UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

LIMITED

ST/CEPAL/Conf.57/L.2/Rev.2
18 December 1976

ORIGINAL: SPANISH/ENGLISH

C E P A L

Economic Commission for Latin America

REGIONAL PREPARATORY MEETING OF THE COUNTRIES OF LATIN AMERICA AND THE CARIBBEAN FOR THE UNITED NATIONS WATER CONFERENCE

Lima, Peru, 30 August-3 September 1976

THE WATER RESOURCES OF LATIN AMERICA

REGIONAL REPORT

76-12-2645

ST/CEPAL/Conf.57/L.2/Rev.2

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This revised version incorporates, as far as possible, the remarks which the delegations at the Regional Preparatory Meeting of the Countries of Latin America and the Caribbean for the United Nations Water Conference, and subsequently a number of Governments, forwarded to the CEPAL secretariat within the specified deadline.

INTRODUCTION

The rapid demographic and economic growth of Latin America and the Caribbean has created an explosive increase in water requirements. The rapidly growing urban areas and the new industrial and mining complexes are putting pressure on the more accessible resources and making it increasingly costly to meet drinking water and sanitation needs. The most economic hydroelectric and irrigation projects have already been exploited to meet the relatively small requirements of the past and it is now necessary to resort to sites further away from the major centres of consumption, which involves higher costs and special constriction problems.

The heterogeneous pattern of income levels and economic activity in these centres of consumption is reflected in very varying requirements for water. Without having brought the problem of water-borne deseases under adequate control, most countries of the region now find themselves confronted with pollution and the new requirements for water which are typical of urban and industrially developed societies.

During the period 1961-1970 4 per cent of gross investment was allocated to water development projects and it is estimated that during the current decade this average percentage will rise even more and possibly reach 5 per cent. Approximately 50 per cent of this future investment would be allocated to hydroelectric projects, 30 per cent to urban water supply and sewage and the rest to irrigation, drainage, flood control and other purposes.

Although Latin America has the most abundant water resources in the world, it has arid areas side-by-side with areas of extremely high rainfall and also areas which pass through successive periods of floods and drought.

The different combinations of heterogeneous requirements and resources makes the situation in each country unique, so that it is necessary to be cautious in making generalizations. However, there are many common features, including the main obstacles to the

/development of

development of these services: the complexity and inoperability of many laws, the multiplicity of institutions, inadequate planning, the lack of financial resources, the irregular supply of personnel and the growing concern about environmental aspects.

In most Latin American countries there is concern to adapt the institutional framework to the new requirements of water management and to adopt short- medium- and long-term policies which, by removing the obstacles mentioned, would ensure the harmonization of economic development with the conservation of water resources and the quality of life which depends on it.

The United Nations Water Conference constitutes an attempt to improve the efficacy of national water policies and international co-operation. Regional preparatory meetings organized jointly by the regional economic commissions and the Secretariat of the conference with the support of the United Nations Environment Programme (UNEP) are a particularly important part of the process of organizing the Conference. These preparatory meetings are expected to produce reports setting forth preliminary joint views on measures which the countries could take either individually, or in groups where aspects of sub-regional interest are involved. These meetings should also indicate what is expected from co-operation through the United Nations system (particularly through co-ordination at the regional level) and from other international bodies.

In order to assist the orientation of discussions at the Regional Preparatory Meeting of the countries of Latin America and the Caribbean, ECLA has prepared this document on the basis of the eleven national reports received at the time of going to press and of the contacts established with governments by a consultant especially engaged for the purpose and by the staff of the Commission which has been following the evolution of water management problems in the region for years.

/I. SUPPLY

I. SUPPLY AND USES OF THE RESOURCE

1. Supply

(a) Main features of water resources and their management

Latin America and the Caribbean as a whole possess abundant water resources. The average rainfall of 1,500 mm 1/ is 50 per cent higher than the world average, which is estimated at 970 mm, 2/ and it contributes some 31 per cent of the total world land drainage entering the oceans. South America, with average rainfall of 1,560 mm, has the highest rainfall of any continent in the world; Central America and the Caribbean islands are also above the world average. The distribution of rainfall is uneven, however, and extremely dry areas are to be found adjacent to others which are excessively humid. The seasonal distribution and annual variation of rainfall is also irregular in a large part of the region and there are areas which have excessive water in certain periods and severe drought in others. The areas with the greatest seasonal variations are generally those with the highest annual variations.

Maps 1, 2, 3 and 4 show the climates of the region, the predominant vegetation, the average rainfall and the annual variation in rainfall, and table 1 shows rainfall by countries and principal areas.

The main orographical system of the region - constituted by the Andes chain and its continuation northwards in the Central American mountain ranges and the main ranges in southern and western Mexico - separates the slopes towards the Pacific and Atlantic Oceans and the Caribbean Sea and also accounts for the existence of some enclosed basins.

1/ ECLA, on the basis of data for the period 1931-1960.

2/ Albert Baumgartner and Eberhard Reichel, The World Water Balance, Munich and Vienna, 1975.

/Table 1

Table 1

LATIN AMERICA AND THE CARIBBEAN: AREA PER COUNTRY AND PER BASIN, AND AVERAGE RAINFALL

	Area (10^3 km^2)				
	Country or region	National basins	International basis	Area of basins	Average rainfall (mm)
Latin America	20 468	8 983	11 485		1 500
Mexico and the Central American isthmus	2 496	1 861	635		1 054
Caribbean	235	225	10		1 267
South America a/	17 735	6 897	10 840		1 560
Argentina a/	2 777	1 809	968		600
River Plate				918	810
Atlántic				1 051	320
Pacific				37	910
Closed				771	410
Bahamas	11.4	11.4			
Barbados	0.4	0.4			
Belize	23.0	11.0	12		
Bolivia	1 099	63	1 036		1 250
River Plate				230	840
Amazon				719	1 380
Closed				150	220
Brazil	8 512	3 222	5 290		1 790
Amazon				3 841	2 510
North Atlantic				1 826	1 090
S. Francisco				629	1 020
South Atlantic				796	1 580
River Plate				1 420	1 200
Colombia	1 139	456	683		2 400
Orinoco				331	2 160
Amazon				330	2 840
Magdalena				284	1 730
Pacific				78	4 970
Caribbean				116	2 690
Costa Rica	51	36	15		3 374
Caribbean				24	
Pacific				27	
Cuba	114	114			1 400
Chile a/	757	677	80		1 030
North of Copiapó				282	40
Copiapó-Aconcagua				92	230
Aconcagua-Bío-Bío				115	920
South of Bío Bío				268	2 390
Ecuador	284	116	168		2 000
Amazon				150	2 310
Pacific				134	1 640
El Salvador	21	8	13		1 820
Guatemala	109	30	79		2 030
Caribbean				86	2 000
Pacific				23	2 130
Guyana	215	45	170		2 560
Haiti	28	21	7		1 380
Honduras	112	86	26		1 710
Caribbean				92	1 780
Pacific				20	1 380
Jamaica	11				1 980
Mexico	1 973	1 536	437		780
Caribbean				716	1 070
Pacific				887	650
Closed				370	390
Nicaragua	130	82	48		2 140
Caribbean				117	2 210
Pacific				13	1 520
Panama	77	72	5		3 094
Caribbean				24	3 745
Pacific				53	2 819
Paraguay	407		407		1 020
Parana				53	1 530
Paraguay				354	940
Peru	1 285	271	1 014		1 690
Pacific				277	200
Amazonas				952	2 180
Closed				56	720
Dominican Republic	49	46	3		1 390
Surinam	163	65	98		2 420
Trinidad and Tobago	5	5			1 260
Uruguay	187	7	180		1 010
Atlantic				65	970
River Plate				122	1 020
Venezuela	912	166	746		1 960
Orinoco				630	2 110
Atlantic				48	1 360
Amazon				43	3 320
Caribbean				191	1 330

Sources: ECLA, on the basis of the national reports prepared for the United Nations Water Statistical Bulletin for Latin America, vol. VII, and other data.

Note: The geographical names used above do not imply any opinion on the demarcation of frontiers or boundaries on the part of the United Nations Secretariat.

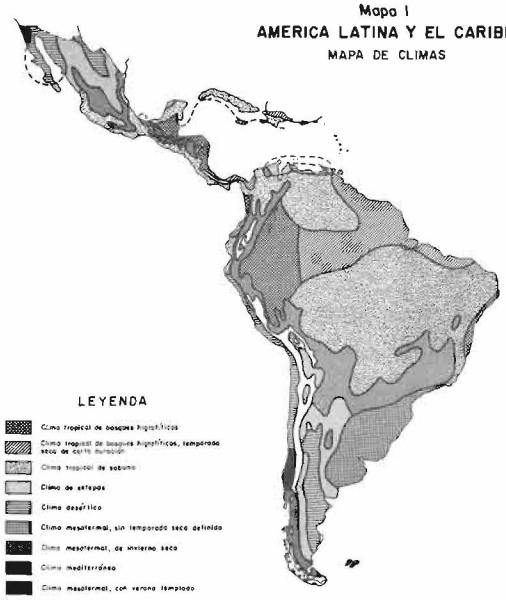
a/ Does not include Antarctic territories.

/Map 1

Mapa 1

AMERICA LATINA Y EL CARIBE

MAPA DE CLIMAS



LEYENDA

- Clima tropical de bosques higrofíticos
- Clima tropical de bosques higrofíticos, temporada seca de corta duración
- Clima tropical de sabana
- Clima de estepas
- Clima desértico
- Clima mesotermal, sin temporada seca definida
- Clima mesotermal, de invierno seco
- Clima mediterráneo
- Clima mesotermal, con verano templado
- Clima de tundra

Mapa 2

AMERICA LATINA Y EL CARIBE

MAPA DE VEGETACION

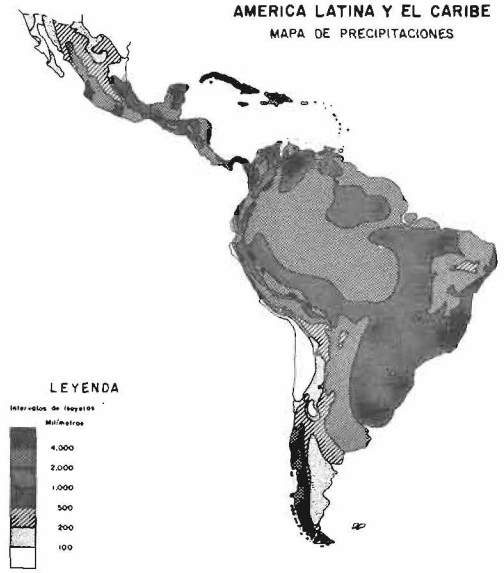
LEYENDA

- Bosque montano
- Bosques xerófilos y matorrales
- Asociación vegetal del Caribe
- Selva pluvial
- Sabana
- Selva subtropical
- Alto matorral tropical
- Pampa
- Mediterránea
- Altoandina
- Estepa alta
- Estepa patagónica
- Desierto
- Asociación vegetal subantártica

Mapa 3

AMERICA LATINA Y EL CARIBE

MAPA DE PRECIPITACIONES



LEYENDA

Intervalos de isoyetas

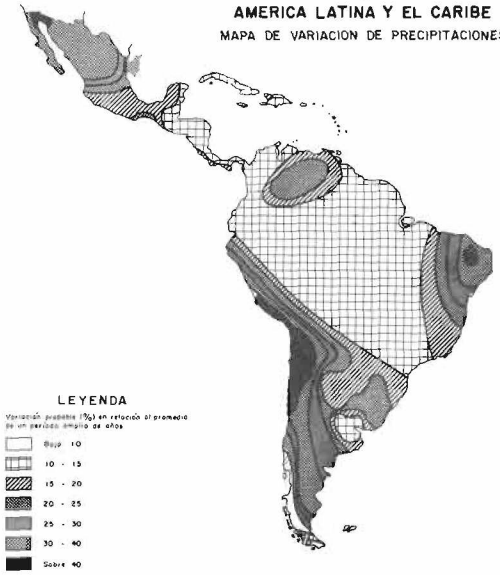
Milímetros

- 4,000
- 2,000
- 1,000
- 500
- 200
- 100

Mapa 4

AMERICA LATINA Y EL CARIBE

MAPA DE VARIACION DE PRECIPITACIONES



LEYENDA

Variación probable (%) en relación al promedio de un período amplio de años

- Bajo 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 40
- Sobre 40

The slope towards the Atlantic and the Caribbean Sea is the most extensive and represents 84 per cent of the total area of the region; the most abundant and extensive rivers are situated on it. Most of the main basins are in tropical areas covered with dense vegetation and have gradients of less than 0.5 per thousand. The rivers maintain a relatively constant flow in the lower reaches but there are great variations of flow in the tributaries. There are, broad flood-prone plains and areas with scant drainage on this slope. The management of the waters is mainly a question of flood control and drainage.

The slope towards the Pacific constitutes 11 per cent of the area of the region. In general the basins have steep gradients and are partly bare of vegetational cover. The rivers have marked variations in flow and many of them carry along large quantities of solid matter. The extremes of rainfall (maximum and minimum) of the region are to be found on this slope, but most of it is arid or semi-arid. The management of the rivers on this slope mainly involves problems of seasonal or interannual regulation and there are plans for transferring water between some of the basins in order to improve the supply in the most arid ones. Various non-traditional water-capture systems have also been tried out in this area.

Some 5 per cent of the total area of Latin America has no direct drainage into any ocean and consists of closed basins which are mainly situated in the high central plateaux. These basins are small and generally have very little vegetational cover, and their rivers have very irregular patterns of flow. Water management involves, inter alia, the regulation of rivers in order to exploit the generally scant resources and drainage projects to prevent the salinization of the land.

There is also abundant subterranean water in Latin America and big water tables, but this resource is little known.

Map 5 provides some information on the flow of the rivers and table 2 summarizes certain characteristics of the main basins. Further on, map 6 shows the main hydrographic divisions.

/Table 2

Table 2

LATIN AMERICA: HYDROLOGICAL CHARACTERISTICS OF THE MAIN RIVER BASINS

Basin	Country	Area 10^3 km^2	Average flow at outlet (m^3/sec.)a/
Mexico and Central America			
Usumacinta-Grijalva	Guatemala-Mexico	131	3 300
Bravo	Mexico	238b/	150
Lerma-Santiago	Mexico	127	364
Balsas	Mexico	110	387
Pánuco	Mexico	74	600
Yaqui	Mexico	50b/	110
Papaloapán	Mexico	47	1 300
San Juan	Costa Rica-Nicaragua	39	1 614
Fuerte	Mexico	34	150
Coco	Honduras-Nicaragua	27	951
Patuca	Honduras	26	825
Ulúa	Honduras	23	526
Coatzacoalcos	Mexico	20	600
Grande de Matagalpa	Nicaragua	20	763
Lempa	Guatemala-Honduras-El Salvador	17	380
Motagua	Guatemala-Honduras	16	252
Caribbean			
Artibonito	Haiti-Dominican Republic	9	240
Cauto	Cuba	9	150
Yaque del Norte	Dominican Republic	8	140
South America			
Amazon	Brazil-Colombia-Ecuador-Peru-Venezuela-Bolivia-Guyana	6 059	180 000
River Plate	Brazil-Bolivia-Argentina-Paraguay-Uruguay	3 092	22 000
Orinoco	Colombia-Venezuela	982	33 000
Tocantino	Brazil	864	17 000
Sao Francisco	Brazil	631	3 900
Parnaíba	Brazil	352	4 800
Magdalena	Colombia	284	6 000
Essequibo	Venezuela-Guyana	155	5 000
Negro	Argentina	122	1 050
Pindaré	Brazil	94	1 100
Doce	Brazil	85	1 000
Courantyne	Guyana-Surinam	79	2 300
Maroni	Surinam-French Guiana	69	2 500
Jequitinhonha	Brazil	70	450
Jaguaribe	Brazil	70	600
Paraguaçu	Brazil	60	650
Paraíba do Sul	Brazil	56	900
Contas	Brazil	55	500
Piranha	Brazil	44	300
Itapicurú	Brazil	37	350
Atrato	Colombia	36	2 700
Guayas	Ecuador	35	1 500
Baker	Chile	33	1 500
Oiapoque	Brazil-French Guiana	31	1 000
Catatumbo	Colombia-Venezuela	31	350

Source: ECLA, on the basis of various data.

Note: The geographical names used above do not imply any opinion on the demarcation of frontiers or borders on the part of the United Nations Secretariat.

a/ The volume at the outlet is estimated on the basis of hydrological information.

b/ Refers only to the Mexican part.

/Map 2


N
ESCALA
Metros cúbicos por segundo.
50 100 500 1000 5000
LEYENDA
Límite de país
Capital de país
Ríos con tráfico de navíos de mar
Ríos con tráfico de navíos fluviales
Mapa 5
AMERICA LATINA Y EL CARIBE
CAUDALES MEDIOS ANUALES
El hecho de que en este mapa figuren determinadas fronteras no significa que sean sancionadas ni aceptadas por las Naciones Unidas

(b) Internationally shared basins and the main agreements in force

Some 71 per cent of the total surface hydraulic resources of the region derive from internationally shared basins, which make up 55 per cent of the total area of the region.

In South America international basins provide 75 per cent of the total flow and in Mexico and Central America, 24 per cent of the total. There is only one major international basin in the Caribbean islands and it produces 17 per cent of the total drainage of the island of Hispaniola.

Table 1 shows the area of the national and international basins in each country and table 2 gives some characteristics of the main basins of Latin America.

The development of the international water resources has been the subject of various treaties between the different countries. Table 3 shows some of the agreements and treaties signed on this matter.

(c) Degree of current utilization and potential supply

In view of the abundant overall water resources of the region, the current level of utilization seems low: only about 3 per cent of the surface water is used for consumption and the installed hydroelectric capacity (27,700 MW) only represents about 8 per cent of the estimated hydroelectric potential (see table 7). Furthermore, only 11.5 million hectares, i.e., 7.3 per cent of the cultivated area, are irrigated (see table 6) although about 25 per cent of the area requires irrigation to various degrees. Despite this relative abundance of water the rapid urban growth, rising incomes and new industrial and mining complexes are currently creating a concentrated demand for water which generally puts very strong pressure on the more accessible resources. It is thus necessary to construct projects with ever greater marginal costs in order to satisfy domestic, industrial and irrigation water requirements simultaneously and to eliminate polluting effluents in an acceptable way. At the same time, since the

/Table 3

Table 3

LATIN AMERICA AND THE CARIBBEAN: TREATIES AND AGREEMENTS ON THE USE OF INTERNATIONAL WATERS

Basin	River	Signatory countries	Year
Colorado	Colorado	Mexico-United States	1966-1970
Río Grande	Grande	Mexico-United States	1906-1933
	Chamizal	Mexico-United States	1963
San Juan	San Juan	Costa Rica-Nicaragua	1888
Artibonito	Artibonito	Haiti-Dominican Republic	1929a/
Catatumbo	Catatumbo and Zulia	Colombia-Venezuela	1903
Amazonas	Tacutú	United Kingdom-Brazil (Guyana)	1940
Maroni	Maroni	France-Netherlands (Surinam)	1915
Zarumilla	Zarumilla	Ecuador-Peru	1944
Tumbes	Puyango	Ecuador-Peru	1971b/
Chira	Catamayo	Ecuador-Peru	1971b/
River Plate	River Plate	Argentina-Uruguay	1910
	Uruguay	Argentina-Uruguay	1938
	Pilcomayo	Argentina-Paraguay	1939
		Argentina-Bolivia-Paraguay	1941
		Argentina-Paraguay	1945
	Uruguay	Argentina-Uruguay	1946
	Acaray	Brazil-Paraguay	1956
	Paraná	Argentina-Paraguay	1958
	Uruguay	Argentina-Uruguay	1961
	Uruguay	Argentina-Uruguay	1968c/
	Paraguay	Argentina-Paraguay	1969c/
	River Plate	Argentina-Bolivia-Brazil-Paraguay and Uruguay	1969-1971c/
	Paraná	Argentina-Paraguay	1971
La Plata	Pilcomayo	Argentina-Bolivia-Paraguay	1972
	La Plata	Argentina-Uruguay	1973
	Paraná	Argentina-Paraguay	1974
	Uruguay	Argentina-Uruguay	1975
	Paraná	Brazil-Paraguay	1975
Mohusuma	Mohusuma, Mauri and azucarero canals	Chile-Peru	1929
Lake Titicaca	Lake Titicaca	Bolivia-Peru	1935
	Lake Titicaca	Bolivia-Peru	1955
	Lake Titicaca	Bolivia-Peru	1957

Source: United Nations, Problemas jurídicos relativos al aprovechamiento y uso de ríos internacionales, Document A/5409, April 1963.

Note: Reference is also made to international rivers in the Declaration of Montevideo, in resolution LXXII of the Seventh Panamerican Conference in 1933 which was signed by all the countries composing the Pan-American Union with the exception of the United States, Mexico and Venezuela.

a/ National report of the Dominican Republic prepared for the United Nations Water Conference.

b/ National report of Peru prepared for the United Nations Water Conference.

c/ United Nations, United Nations Treaty Series, N° 671, 1969 and N° 709, 1970.

/most economic

most economic hydroelectric projects have already been developed, recourse is being made to increasingly distant sources which require very high investment in order to exploit large concentrations of potential which can only be developed on a large scale.

Approximately 80 per cent of the population of Latin America lives in areas where the rainfall amounts to between 500 and 2,000 mm a year, and even in areas of very concentrated demand no major problems are expected to arise in regional supply as a whole from the point of view of the availability of the natural resource. The difficulty lies in the conflict between different types of use and, as has been said, in the need to resort to increasingly distant sources. The remaining 20 per cent of the population is divided equally between those who live in very humid areas and those who live in semi-arid and arid areas. The problem of supply naturally arises in the case of the population of the latter areas, which totals some 30 million inhabitants out of a total of 326 million. Furthermore it should be stressed that about 94 million persons who live in the rural areas of the region still do not have reasonable access to the minimum quantities of drinking water essential to their health and welfare.

In arid and semi-arid areas subterranean water generally offers the greatest potential and the same is true of densely populated areas where subterranean water is used as an additional resource. At the present time less is known about this resource than surface water because of the lack of systematic research, although it is quite widely used in some areas. For example, most of the supply for medium-sized and small towns throughout the region derives from subterranean water and it is also important for irrigation in Argentina, Cuba, Mexico and Peru. It is being used increasingly in the large towns of Latin America to supplement the supply to the drinking water networks and is also drawn from private wells for industrial purposes which causes problems of control in ensuring rational management.

/The advanced

The advanced methods offered by technology have been used only in recent years for research on subterranean water. Some positive examples are the very wide-ranging hydrogeological studies carried out in North-East Brazil and in the North-West of Mexico City. Important research has also been done in a number of places including Peru, Argentina (mainly in the Cuyo area), the high plateau of Bolivia and the border area of Paraguay, with the assistance of the United Nations Development Programme (UNDP).

The reliability of this resource and the frequent underestimation of its social costs leads users to overexploit the aquifer in the absence of quotas or rates. This seems to have been the case in the outskirts of Buenos Aires, Mendoza and Quito, for example. In Mexico, too, there are 32 areas where the subterranean water is overexploited. In the Andes region much work remains to be done to acquire sufficient knowledge about the supply of this type of water, since the geomorphology is complex and requires much research on the terrain.

In Latin America there has been very little development of flood control and drainage as a method of making land suitable for agriculture and livestock rearing. In this respect there is major potential in the humid and very humid areas of the region, which are mainly in the tropical zone. In recent years this possibility has been studies in the lower valleys of the Cauca and the Magdalena (Colombia), the high plains of Orinoco (Venezuela), the Ecuadorean coast and the plains of Paraná (Argentina) and Beni (Bolivia). Venezuela is making rapid progress with its on-going projects such as the project for the south-west area of Lake Maracaibo, and in experimental studies, such as that of the Módulos de Apure. The lack of knowledge about the long-term behaviour of the relevant ecosystems raises major questions which are under discussion.

2. Utilization

(a) The patterns and trends of utilization

Economic activity and the population have concentrated in relatively small areas of each country because of geographical and historical factors, and as a result the demand for water is also concentrated (see map 7).

/Map 7


RIO COLORADO
INTERIOR NORTE
CALIFORNIA
RIO BRAVO
INTERIOR SUR
PACIFICO NORTE
GOLFO MEXICO
YUCATAN
CARIBE
ISLAS CARIBE
MARACAIBO
VENEZUELA CENTRAL
MAGDALENA
ORINOCO
GUAYANAS
PACIFICO TROPICAL
AMAZONICA
NOR ESTE BRASIL
SAN FRANCISCO
PACIFICO SECO
INTERIOR ALTIPLANO
ATLANTICO SUR
PLATA
INTERIOR ARGENTINA
CENTRAL DE CHILE
PAMPA
PATAGONIA
PACIFICO SUR
N
Mapa 6
AMERICA LATINA Y EL CARIBE
DIVISIONES HIDROGRAFICAS PRINCIPALES
LEYENDA
Límite de país
Capital de país
Ciudades de más de 1.000.000 de habitantes
División de cuencas
Fuente: CEPAL, Investigaciones en curso del proyecto Agua, Desarrollo y Medio Ambiente. - ADEMA - (CEPAL / PNUMA)
Nota: El hecho de que en este mapa figuren determinadas fronteras no significa que sean sancionadas ni aceptadas por las Naciones Unidas.

The gross geographical product of Latin America, which has grown at an annual average of 5.9 per cent during the last five years (1971-1975) is changing in structure in that the industrial manufacturing sector is increasing its share, which reached 24 per cent in 1975. Furthermore, the population is increasing very rapidly (2.9 per cent a year); in 1975 it amounted to 326 million inhabitants and it is estimated that in the year 2000 it will reach 626 million. The degree of urbanization is also high; in 1975 it was 57.7 per cent and it is estimated that it will reach 70 per cent in the year 2000.3/

It is expected that there will be a considerable increase in the utilization of water, and according to the estimates of a group of countries (see table 4) total extraction will rise by 120 per cent between 1975 and 2000; of this, extraction for industrial purposes will rise by 350 per cent and that for irrigation by 70 per cent.

In the same group of countries, however, the total extraction predicted for the year 2000 will represent only about 10 per cent of the supply of water.

(b) Domestic and urban uses

The urban public services (which supply the water required for the home, light industry and public cleansing and ornament) have followed the type of development characteristic of communities with predominantly low incomes. When the service was deficient and the supply to homes relatively small (and public sources predominated) the unit demands were low. When modern services were established, without meters or with low rates, demand increased greatly. In such cases consumption has been checked by supply where the latter has been affected by limitations of the services or water sources, and in many cases various forms of rationing have been introduced. The strict measurement of consumption and the fixing of remunerative rates (very rare) have had the desired effect of rationing utilization.

3/ The urban population is currently increasing by 4.2 per cent a year.

/Table 4

Table 4

LATIN AMERICA AND THE CARIBBEAN: EXTRACTION OF WATER ACCORDING TO USE

(Millions of m^3 per year)

	1975					2000				
	Total consumption	Irrigation	Drinking water	Other uses	Hydro-electricity	Total consumption	Irrigation	Drinking water	Other uses	Hydro-electricity
Argentina	27 737	20 259	2 465	5 013		50 030	23 520	4 650	21 860	
Cuba	8 100	6 700	1 100	300		17 966a/	15 363	1 551	1 052	
Chile	16 792	15 385	768	639	26 200	28 832	25 509	2 032	1 291	82 600
El Salvador	1 000	830	170		3 700	4 100a/	3 300	800		8 900
Jamaica	316	286	11	19	-	443	365	28	50	
Mexico	54 200	47 500	2 700	4 000	75 200	109 500	69 000	9 900	30 600	254 800
Nicaragua	1 864	330	162	402	470	10 430	3 150	450	530	6 300
Panama	4 007	1 010	157	2 840b/	3 630	9 480a/	4 400	280	4 800b/	13 200
Venezuela	4 071	2 440	1 563	168		23 009	16 837	5 741	431	
Total	118 087	94 740	9 096	13 381		253 790	161 444	25 432	60 614	

Sources: Mexico, National Water Plan; Venezuela, Water Resources Development Plan; other countries: national reports prepared for the United Nations Water Conference.

a/ Projection for 1990.

b/ Includes navigation in the Panama Canal.

/In the

In the Charter of Punta del Este it was proposed that during the decade 1960-1970 "drinking water and drainage should be made available to at least 70 per cent of the urban population and 50 per cent of the rural population". The goals for drinking water were attained at the urban level, since the proportion of the population supplied with water rose from 58 per cent in 1961 to 79 per cent in 1974 (see table 5), but in the rural area the goals proved to be very ambitious and although the service more than doubled between 1961 and 1974, the population supplied with water in 1974 only amounted to 26 per cent of the rural inhabitants.

It should be noted that when the process of agrarian reform is accompanied by greater dispersion of the rural population, the investment per inhabitant supplied with water increases.

The Third Special Meeting of Ministers of Health (Santiago, 1972) set the goal for 1980 of extending home supply to 80 per cent of the urban population or, as a minimum, reducing the population currently without the service in these areas by 50 per cent, while the goal in rural areas was to supply water to 50 per cent of the population or, as a minimum, to reduce by 30 per cent the population without this service.

(c) Industrial use

Industry is connected with the public networks when its requirements are relatively low, and it often has its own supply from wells or surface reservoirs as an alternative. The major industries (iron and steel, paper, pulp, petrochemicals, sugar refineries, coffee mills, abattoirs and tanneries, etc.), which because of the scale of their requirements have their own supply of water, have sought sites with direct access to abundant sources of water, sometimes far from towns. In general, the source most frequently used for industrial supply has been subterranean water because it can usually be obtained exactly where it is required. In some cases it is possible to use subterranean water which is unsuitable for drinking or irrigation by subjecting it to some type of treatment whose cost is not a significant part of the final product.

/Table 5

Table 5

LATIN AMERICA AND THE CARIBBEAN: DRINKING WATER AND SEWERAGE SERVICES (END OF 1974)

(Population in thousands) a/

Country or other political unit	Date of the information	Water supply: Total: Population	Water supply: Total: Population served: Home supply	Water supply: Total: Population served: Easy access	Water supply: Total: Population served: Total	Water supply: Total: Population served: Percentage	Water supply: Urban: Population	Water supply: Urban: Population served: Home supply	Water supply: Urban: Population served: Percentage	Water supply: Urban: Population served: Easy access	Water supply: Urban: Population served: Total	Water supply: Urban: Population served: Percentage	Water supply: Rural: Population	Water supply: Rural: Population served: Home supply	Water supply: Rural: Population served: Easy access	Water supply: Rural: Population served: Total	Water supply: Rural: Population served: Percentage	Sewerage: Urban: Population served: Number	Sewerage: Urban: Population served: Percentage	Sewerage: Rural: Population served: Number	Sewerage: Total: Population served: Number	Sewerage: Total: Population served: Percentage
Argentina	Nov. 74	25 100	15 600	1 200	16 880	67	19 120	14 500	76	1 000	15 500	81	5 980	1 180	200	1 380	23	7 200	38	-	7 200	29
Barbados	Feb. 75	241	156	85	241	110	111	109	98	2	111	100	130	47	83	130	100	-	-	-	-	-
Belize	Dec. 74	135	50	27	77	57	74	41	55	24	65	88	61	9	3	12	20	4	5	-	4	3
Bolivia	Nov. 74	5 440	918	317	1 235	23	1 850	862	47	200	1 062	57	3 590	56	117	173	5	440	24	189	629	12
Brazil b/	Dec. 73	103 141	42 428	17 148	59 576	58	60 618	32 128	53	14 548	46 676	77	42 523	10 300	2 600	12 900	30	17 600	29	1 400	19 000	18
Colombia	Dec. 74	21 100	11 100	1 800	12 900	61	12 400	9 800	79	1 000	10 800	87	8 700	1 300	800	2 100	24	8 300	67	370	8 670	41
Costa Rica	Jan. 75	1 967	1 266	160	1 426	72	726	689	95	36	725	100	1 241	577	124	701	56	314	43	-	314	16
Cuba	June 73	8 916	4 747	-	4 747	53	5 394	4 587	85	-	4 587	85	3 522	160	-	160	5	2 170	40	107	2 277	26
Chile	Dec. 74	10 229	5 910	1 226	7 136	70	7 829	5 550	71	1 106	6 656	85	2 400	360	120	480	20	3 117	40	180	3 297	32
Ecuador	Nov. 74	6 481	1 341	762	2 103	32	2 683	1 341	50	419	1 760	66	3 798	-	343	343	9	1 549	58	32	1 581	24
El Salvador	Dec. 74	3 931	901	1 179	2 080	53	1 554	746	48	601	1 347	87	2 377	155	578	733	31	584	38	-	584	15
Guatemala	Dec. 74	6 001	912	1 344	2 256	38	2 163	828	38	915	1 743	81	3 838	84	429	513	13	817	38	-	817	14
Guyana	Dec. 74	827	388	265	653	79	241	202	84	18	220	91	586	186	247	433	74	94	39	-	94	11
Haiti	Dec. 74	4 513	175	372	547	12	778	172	22	264	436	56	3 735	3	108	111	3	-	-	-	-	-
Honduras	Dec. 74	2 654	730	369	1 099	41	995	574	58	291	865	87	1 659	156	78	234	14	401	40	1	402	15
Jamaica	Mar. 73	1 954	828	882	1 710	88	528	507	96	9	516	98	1 426	321	873	1 194	84	-	-	-	-	-
Mexico	Dec. 74	56 600	30 740	1 700	32 440	57	35 200	24 240	69	1 700	25 940	74	21 400	6 500	-	6 500	30	14 500	41	80	14 580	26
Nicaragua	Dec. 74	2 106	776	351	1 127	54	989	695	70	294	989	100	1 117	81	57	138	12	260	26	-	260	12
Panama	Dec. 74	1 646	829	416	1 245	76	820	749	91	71	820	100	826	80	345	425	51	582	71	5	587	36
Paraguay	Nov. 74	2 478	214	19	233	9	927	212	23	18	230	25	1 551	2	1	3	0.2	144	16	-	144	6
Peru	Dec. 74	15 273	5 031	1 943	6 974	46	8 900	4 830	54	1 400	6 230	70	6 373	201	543	744	12	4 400	49	12	4 412	29
Dominican Republic	Dec. 74	4 562	1 614	841	2 455	54	2 019	1 355	67	500	1 855	92	2 543	259	341	600	24	507	25	381	888	19
Surinam	Dec. 74	413	175	108	283	68	211	156	74	55	211	100	202	19	53	72	36	85	40	-	85	21
Trinidad and Tobago	Dec. 70	1 060	562	460	1 022	96	358	297	83	59	356	99	702	265	401	666	95	181	51	2	183	17
Uruguay	Nov. 74	3 035	2 213	323	2 536	84	2 455	2 113	86	238	2 351	96	580	100	85	185	32	1 255	51	262	1 517	50
Venezuela	Dec. 73	12 860	8 074	1 330	9 404	73	8 700	6 320	73	1 330	7 650	88	4 160	1 754	-	1 754	42	4 070	47	164	4 234	33
Countries and territories of the Eastern Caribbean	Dec. 74	518	137	244	381	74	176	77	44	58	135	77	342	60	186	246	72	15	9	-	15	3
Total		303 181	137 895	34 871	172 766	57	177 819	113 680	64	26 156	139 836	79	125 362	24 215	8 715	32 930	26	68 589	39	3 185	71 774	24

Source: Annual Report of the Pan-American Health Organization.

a/ Current estimates of the inhabitants and population served, submitted by the countries to the Department of Environmental Engineering and Science, Pan-American Sanitary Bureau (PASB).

b/ The data on the population served are based on the figures for percentage of population served given in response to the questionnaire of the World Health Organization (WHO) in 1970.

/Some countries

Some countries believe that the consumption of water for industrial purposes, including use in thermal power stations, will increase by 350 per cent by the end of the century (see table 4).

Generally only a proportion of the water used by industry evaporates or is incorporated into production; the rest returns to the watercourses and causes severe pollution.

(d) Irrigation

Agricultural needs, mainly drainage, flood-control and water for irrigation, are a latent factor in all the areas where irrigated agriculture is profitable. The regions where irrigation has traditionally been practised as the only viable form of agriculture are mainly concentrated in the Andes zone of Argentina, the Central Valley and the transverse valleys of Chile, the Peruvian coast, North-West Mexico and some parts of central and southern Brazil, which together represent about 75 per cent of the irrigated area of Latin America (see table 6). The total irrigated area amounts to some 11.5 million hectares if an irrigated area is considered as one with an irrigation infrastructure, adequate security of supply and actual production. It is very difficult to give exact figures because there is disagreement on the criteria to be followed in determining adequate supply or a complete irrigation infrastructure 4/ (see map 8).

Table 6 also shows the irrigated area by countries, and the future projections. It should be noted that part of the water used for irrigation is re-used where topographical conditions permit. Farmers show interest in introducing irrigation as one of their agricultural techniques but usually tend to be reluctant to meet the costs out of their own pockets; in general this activity is heavily subsidized by the State. Because their importance is recognized, irrigation projects have been promoted on their own merits

4/ In some countries irrigation which provides for harvests in eight out of every ten years is considered adequate.

/Table 6

Table 6

LATIN AMERICA AND THE CARIBBEAN: AREAS CULTIVATED AND IRRIGATED, BY COUNTRIES

(Millions of hectares)

	Territory	Cultivated area a/	Harvested area b/	Irrigated area	Irrigated area as a percentage of cultivated area	Projected irrigation in the year 2000	Percentage increase in the area irrigated 1975-2000
Argentina	278.00	40.00	15.037	1.24	3.1	1.48	20
Barbados	0.04	0.02	0.018				
Bolivia	109.80	1.00	0.887	0.08	8.0		
Brazil	851.20	70.00	39.380	0.60	0.8		
Chile	75.70	2.80	1.412	1.62	58.0	2.48	52
Colombia	113.90	4.00	3.799	0.25	6.2		
Costa Rica	5.10	0.35	0.395	0.06	17.0	0.17	180
Cuba	11.10	3.70	1.817	0.68	18.2		
Ecuador	28.40	3.80	1.635	0.18	4.7		
El Salvador	2.10	0.37	0.697	0.03	8.0	0.10	230
Guatemala	10.90	1.50	1.779	0.02	1.3		
Guyana	21.50	0.30	0.079	0.19	30.0		
Haiti	2.80	0.37	0.930	0.05	13.5		
Honduras	11.20	0.78	0.662	0.05	6.4		
Jamaica	1.10	0.22	0.180	0.02	9.1	0.03	50
Mexico	197.30	18.60	15.180	4.70	25.0	8.50	80
Nicaragua	13.00	0.89	0.794	0.05	5.6	0.20	300
Panama	7.70	0.31	0.473	0.03	9.7	0.13	330
Paraguay	40.70	0.80	0.713	0.02	2.5		
Peru	128.50	3.10	1.700	1.25	40.0		
Dominican Republic	4.90	0.96	0.672	0.12	12.5	0.24	100
Surinam	16.30	0.06		0.02	33.0		
Trinidad and Tobago	0.50	0.08	0.082				
Uruguay	18.70	1.00	1.126	0.05	8.0		
Venezuela	91.20	1.80	1.633	0.30	16.6	1.50	400
Total	2 041.64	156.80	91.080	11.61	7.4		

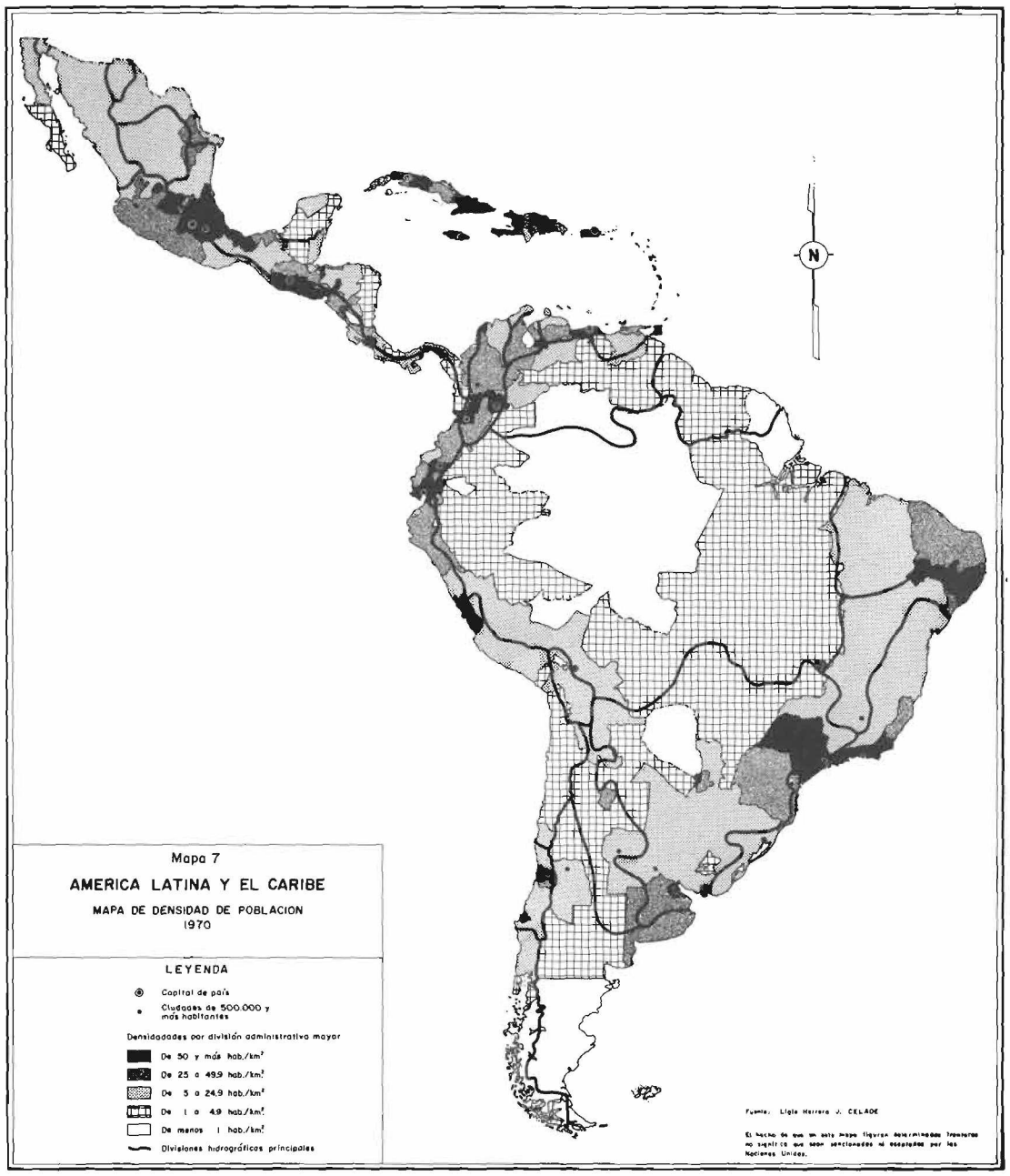
Sources: National reports prepared for the United Nations Water Conference (Argentina, Bolivia, Chile, Costa Rica, Cuba, El Salvador, Jamaica, Nicaragua, Panama, Peru, Guatemala and Venezuela); Mexico: National Water Plan; other countries: direct information.

Note: The geographical names used above do not imply any opinion on the demarcation of frontiers or borders on the part of the United Nations Secretariat.

a/ Includes area harvested and artificial pastures (1970).

b/ Estimates of the Joint ECLA/FAO Agriculture Division (1974).

/Map 8


N
Mapa 7
AMERICA LATINA Y EL CARIBE
MAPA DE DENSIDAD DE POBLACION
1970
LEYENDA
Capital de país
Ciudades de 500.000 y más habitantes
Densidadades por división administrativa mayor
De 50 y más hab./km²
De 25 a 49.9 hab./km²
De 5 a 24.9 hab./km²
De 1 a 4.9 hab./km²
De menos 1 hab./km²
Divisiones hidrográficas principales
Fuente: Ligia Herrera J. CELADE
El hecho de que en este mapa figuren delimitadas fronteras no significa que sean sancionadas ni aceptadas por las Naciones Unidas.

without being compared with other methods of attaining the same production objectives and as a result many of the projects proposed have been questioned and attempts are being made to make better use of the systems already constructed. However, it is estimated that there are still a great many projects of high yield which are worth comming out in the near future in the regions where irrigation is traditional. This could easily double the 11.5 million hectares currently irrigated and thus make use of just over half the potential of the region, which is estimated at some 30 million hectares (see table 6). In the humid regions of Latin America where irrigation has not been practised or has been relatively insignificant but where there is a dry season during which a second or third harvest could be grown by means of the artificial application of water, interest in supplementary irrigation is increasing and there may be many cases in which it would be justified.

(e) Hydroelectricity

This is the use which is increasing most rapidly in the region and the economic viability of hydroelectric projects is frequently the basis for the development of water resources for multiple purposes. The critical points of this use are that it returns the water at a lower level and generally at different rates. There are various cases in Latin America where the irrigation requirements downstream of a hydroelectric plant have made it necessary to construct another dam so that the generation of power can be made compatible with the subsequent use of the water for irrigation.

During the past decade hydroelectric generation has increased at the high rate of about 9 per cent a year. All the countries of the continent have made substantial progress in this sphere. The rise in the price of petroleum has naturally had the effect of making the exploitation of hydroelectric resources more attractive. Now that all the most economic projects and those nearest the centres of consumption have been developed, the phase of major interconnexions and the incorporation of massive concentrations of potential has begun, with Brazil taking the lead with the biggest projects.

/The installed

The installed capacity of the hydroelectric plants of Latin America may rise from 27,700 MW in 1974 to 57,200 MW in 1980 if the current plans are completed (see table 7 and map 9). This form of primary energy will continue to be predominant, for it is estimated that it will rise from 50 per cent to over 58 per cent of the total energy generated during the decade.

Table 7 also presents a summary of information on the estimates available potential and installed capacity by country.

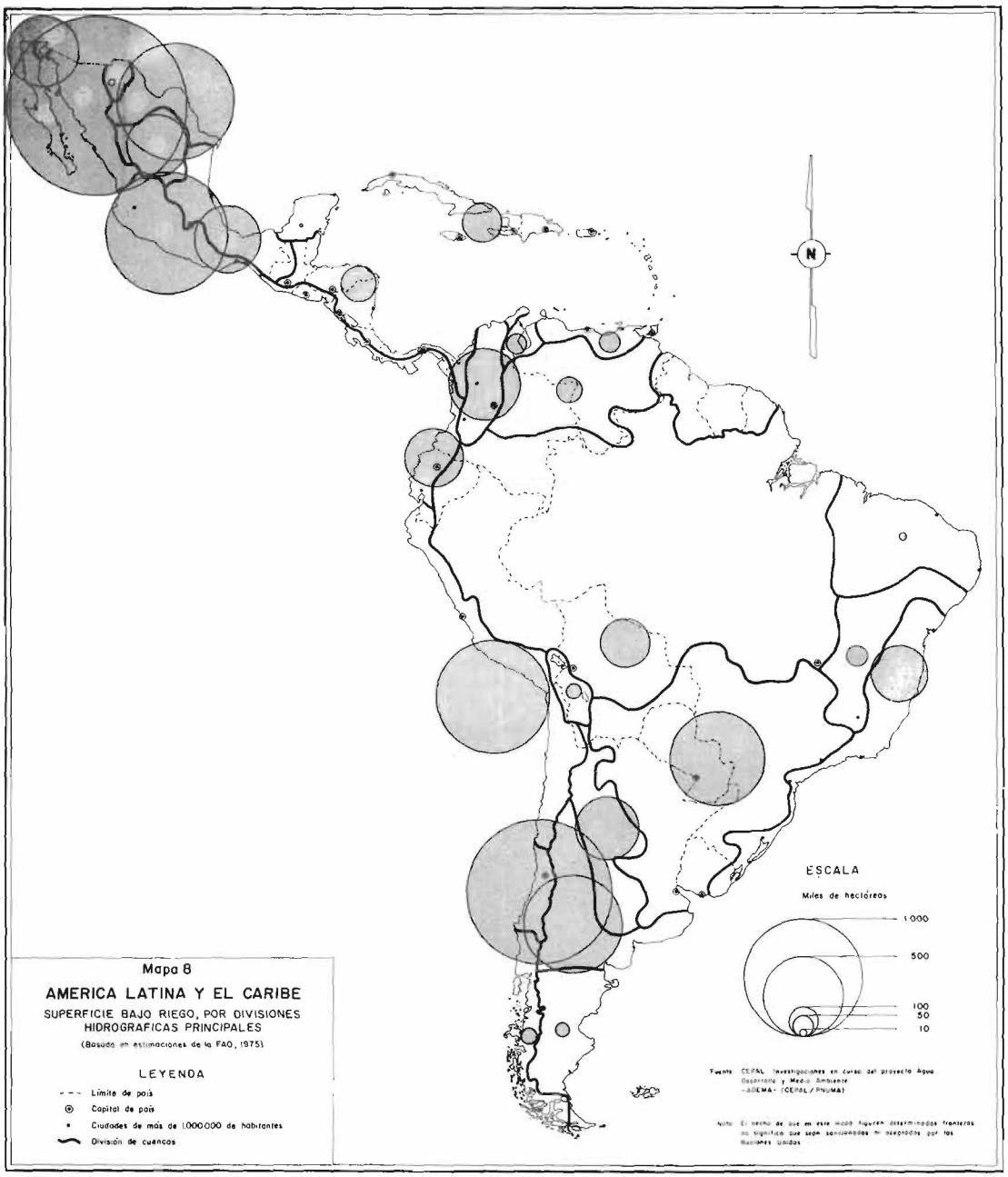
(f) River transport

The major rivers of Latin America especially the River Plate, Amazon, Orinoco and Magdalena-Cauca systems, are important for water transport. Except where transportation related to mining, as in Venezuela, and in the case of the Panama Canal, which uses a substantial flow of fresh water, however, river transport has stagnated in recent years.

(g) Recreation

The use of rivers and lakes for recreation has been relatively low (except in Argentina, Brazil, Chile, Guatemala and Mexico), possibly because most of the population of Latin America is concentrated on the periphery of the continent where there is easy access to maritime beaches. This activity was largely overlooked when planning the major water projects of the past, because demand was limited to narrow circles. Nevertheless, the increase in the income of the population will lead to a rise in this use and it will be necessary to consider this aspect when designing projects.

/Table 7



Mapa 8

AMERICA LATINA Y EL CARIBE

SUPERFICIE BAJO RIEGO, POR DIVISIONES HIDROGRAFICAS PRINCIPALES

(Basado en estimaciones de la FAO, 1975)

LEYENDA

- Límite de país
- Capital de país
- Ciudades de más de 1.000.000 de habitantes
- División de cuencas

Table 7

LATIN AMERICA AND THE CARIBBEAN: HYDROELECTRIC POTENTIAL, INSTALLED CAPACITY AND GENERATION, BY COUNTRIES

	Hydroelectric potential (MW)		Installed capacity (MW)		Installed hydroelectric capacity as a percentage of the total	Generation GWh (1974)	
	Mean a/	Utilizable b/	Hydroelectric	Total		Hydroelectric	Total
Argentina	10 900		1 532	9 140	16.7	6 020	27 925
Bahamas			-	250	-	-	660
Barbados			-	67	-	-	203
Bolivia	14 700		241	350	68.8	764	993
Brazil	102 700		14 037	17 199	81.6	65 492	72 396
Chile	22 500	19 700	1 464	2 572	57.0	6 048	9 297
Colombia	38 200		2 322	3 517	66.0	9 185	13 483
Costa Rica	2 100	8 500	242	362	66.8	1 353	1 670
Cuba	700		44	1 645	2.7	110	6 016
Ecuador	17 200		135	438	30.8	480	1 359
El Salvador	400		108	283	38.1	479	1 018
Grenada			-	7	-	-	25
Guatemala	4 400	4 900	102	252	40.4	336	1 104
Guyana	4 700		-	170	-	-	386
Haiti	400		47	83	56.6	138	170
Honduras	3 500	2 400	69	149	46.3	408	488
Jamaica	300		20	698	28.6	122	2 283
Mexico	11 100		3 679	9 647	38.1	16 908	40 752
Nicaragua	2 200	2 800	107	262	40.8	393	891
Panama	2 400	3 570	9	333	2.7	100	1 408
Paraguay	5 400		90	201	44.7	440	523
Peru	32 700		1 388	2 265	61.2	5 219	7 272
Dominican Republic	800		95	446	21.3	187	1 509
Surinam	2 600		180	301	59.8	1 006	1 588
Trinidad and Tobago	100		-	414	-	-	1 204
Uruguay	900		252	576	43.70	1 360	2 355
Venezuela	34 700	54 700c/	1 575	4 381	35.90	7 266	17 725
Total	315 600		27 738	56 008	49.50	123 814	214 703

a/ ECLA, theoretical estimate. (See Economic Bulletin for Latin America, Vol. XII Nº 1, May 1967.)

b/ National reports prepared for the United Nations Water Conference.

c/ National Water Plan.

/(h) Fishing

(h) Fishing

Fishing is fairly important for the communities which live near the major rivers and lakes as a source of food and of produce for marketing. Judging by the few studies which have been made on the subject, this activity could be developed much further. At the present time it only rarely receives official encouragement, and in many cases it is threatened by pollution and other changes in the flows. It is estimated that the regional catch in inland waters amounted to 200,000 tons in 1974, the leading countries being Brazil, Colombia, Venezuela and Mexico, which together produced half of this output.

(i) Mining

Mining and the associated processes of concentration and refining are located near the deposits, generally in upland areas, and this use of water frequently conflicts strongly with other uses in areas where the resource is scarce.

In northern Chile, for example, in the basin of the river Loa, which has an average year-round flow of about 2.5 m^3/sec., the needs of the large copper mine at Chuquicamata and of the saltpetre works at María Elena and Pedro de Valdivia compete with the uses in the towns of Antofagasta and Tocopilla and the requirements for the irrigation of some 3,000 hectares. Other similar though perhaps less severe examples can be found in other areas of Chile and in traditional mining countries such as Bolivia and Peru. In Peru the iron mine at Marcona, near Ica, installed a desalinization plant to supply water to the population. Very little information has been compiled in the region on these uses.

Furthermore, there are dozens of rivers in the region which have varying degrees of pollution caused by mining activities. Sometimes the pollution affects other uses, including urban use (Bolivia, Chile, Peru, Venezuela, Brazil and Mexico).

/3. Basic

3. Basic information on water availability and uses

(a) Study of the resource

Since 1960 meteorology and hydrometry have received considerable stimulus, partly as a result of the support received through international co-operation. The United Nations Development Programme (UNDP), for example, has allocated some 35 million dollars throughout the region to broaden and improve the networks of measuring stations. Total investment, including that of the governments themselves, appears to have reached a total of over 70 million dollars over the last 15 years. The stimulus referred to has led to an increase in the number of pluviometers and fluviometers of 5.4 and 4.2 per cent per year respectively, which, though lower than the rate of increase in drinking-water installations and much lower than that of hydroelectricity, nevertheless represents some progress compared with the situation which existed in previous years. Even so, although the current balance is encouraging because a healthy rate of growth is being maintained it does not meet the requirements of the more rigorous planning of water management which is considered necessary for the near future. It may be noted however, that there are pluviometric and fluviometric stations operated by individuals or independent bodies (mining companies, railways, agricultural and electricity enterprises, etc.) which provide a further source of information in addition to the statistics of the official services. If the figures for the number of pluviometers and fluviometers per country in relation to population, territorial area and total annual investment are studied and compared with those for more developed countries, it can be clearly seen that much improvement is needed in both the coverage of these services and their general efficiency (see table 8). Fortunately, international co-operation promoted by United Nations bodies (UNESCO, the World Meteorological Organization (WMO) and UNDP), among others, is making possible a major flow of advice and transfer of technology. One example, worthy of note is the Central American Hydrometeorological Project which is being carried out with the assistance of UNDP and WMO. There is considerable

/Table 8

Table 8

LATIN AMERICA AND THE CARIBBEAN: HYDROMETRIC INSTALLATIONS

	Area 10^3 km^2	Population density (inhabitants/ km^2) a/	Pluvio-metric stations	Evapori-meters	Fluvio-metric stations	Wells for observa-tion of subterra-nean water	Quality	Sedimen-tation
Argentina	2 776.6	8.4	3 785	300	702	133	70	35
Barbados	0.4	553.8						
Bolivia	1 098.6	4.2	347	6	63			
Brazil	8 512.0	11.0	4 028	68	1 560			
Colombia	1 138.9	17.4	888	69	442			
Costa Rica	50.7	32.7	524	12	83		31	17
Cuba	114.5	68.1	2 929	57	79	1 800	67	30
Chile	756.9	11.7	1 011	130	391	351	800	40
Ecuador	283.6	21.0	353	24	216			
El Salvador	21.4	166.2	186	17	56	33	36	19
Guatemala	131.8	45.0	375	15	87		14	19
Guyana	215.0	2.6	225	12	46			
Haiti	27.8	111.2	60	2	11			
Honduras	112.1	23.0	232	54	87		5	8
Jamaica	11.0	140.9	395		88	350	77	
Mexico	1 972.5	24.6	3 200	96	1 200			
Nicaragua	130.0	15.6	349	74	72		7	7
Panama	75.6	18.8	310	40	86			3
Paraguay	406.8	5.7	110	4	32			
Peru	1 285.2	9.5	790	66	314	500		
Dominican Republic	48.7	82.8	300		80			
Surinam	136.0	3.3	191	6	98			
Trinidad and Tobago	5.1	197.0	153					
Uruguay	186.9	14.6	947	19	86			
Venezuela	912.1	8.4	1 377	180	700	1 130		
Recommended minimum density (N° stations/ 10^3 km^2)			1.6	0.03	0.6		0.04	0.10

Sources: ECLA, on the basis of national reports prepared for the United Nations Water Conference. Some countries only provided information on official networks and this has been supplemented with other direct information from ECLA on networks operated by other institutions (universities, enterprises, etc.).

Note: The geographical names used above do not imply any opinion on the demarcation of frontiers or borders on the part of the United Nations Secretariat.

a/ Organization of American States (AS), América en cifras, 1972.

b/ World Meteorological Organization, Guide to Hydrological Practices N° 168.

/awareness of

awareness of the possibilities offered by the modern techniques of remote sensors, the use of radioactive tracers, synthetic hydrology and so forth, and there is reason to believe that such techniques will be applied in an effective manner, judging by the willingness being shown to provide the institutional apparatus and the necessary funds.

Very few countries have a satisfactory organization to co-ordinate the need for basic integrated studies, for which a central body would be responsible, with the collection of hydrological and hydrometeorological information, which would be compiled by specialized institutions in their respective fields. Many duplications and omissions still remain, as is the case in general in the institutional organization for water administration and these will have to be remedied.

It should be noted that at the stage of preparing these data there is generally little assistance for the planner who needs to know the characteristics of water resources. The sectoral bodies have prepared registers of existing projects, some of which are more complete than others, but these are rarely available for the use of those who, wishing to carry out unified operations or combined projects, need to gain a full idea of the national pattern of water resources. This task is certainly very complex but it is not impracticable.

Various countries of the region, including Argentina, Chile, Cuba, Mexico and Venezuela, have made a complete study of their water resources. Although this work was done in countries where ample information is available, that information still had to be supplemented with many hypotheses and adaptations of outside figures in order to attain the desired result.

The question of environmental protection gives rise to a further need for information. Some of the most widely-known indexes on the quality of water in the most severely affected areas of the countries are available, but there is no complementary information which would make it possible to work out the chain of the biological and ecological consequences of environmental influences. This subject is virtually

/untouched and

untouched and will have to be tackled in the near future. There are very few stations in the region for measuring water quality and sediment content, and considerable improvement is needed.

There is a serious shortage of equipment to measure other forms of the resource, such as subterranean water, snow and glaciers, and in some cases there is no great concern about carrying out the task. Table 8 gives a summary of information on the water measuring equipment in the region and provides some comparative figures on the density of instruments recommended by WMO and the investment made under this heading in certain countries.

It should be noted that the averages shown in the information for individual countries do not accurately reflect the situation in the large countries where economic activity is concentrated in a few areas, since although the coverage for the most important areas is good there are other areas which are currently less active and where the evaluation of the resources has only recently begun.

(b) Methods utilized to estimate water use

In making estimates of demand it is important to have information on past consumption and the background to its evolution.

In Latin America, no statistics are generally prepared on the volume of water used by the various individual sectors of activity. In the towns and irrigated areas a register is usually kept of the volume supplied to the networks and canal system but information on the volume actually used by the consumer is available in only a very few cases.

Despite the ability and expertise of the Latin American professionals who work in this sphere, there is still a relative degree of inefficiency and projections of offer and demand are calculated with the use of fairly simple methods. This has not produced satisfactory results, not so much because of ignorance of the theoretical instruments offered by modern technology as because the basic information available tends to be inadequate and there is a very wide margin of uncertainty about the hypotheses of technological, economic and social change.

/Demand forecasts

Demand forecasts have not always been confirmed in practice. There are cases where hydroelectric power and drinking water have been supplied at highly subsidized costs and encouraged excessive consumption or highlighted unsatisfied demand. In other cases, such as irrigation, too much investment has been made in works while insufficient allowance has been made for the limitations of the users and of those who have to operate the irrigation projects once the basic apparatus has been constructed.

The underestimation of demand could perhaps have been avoided in many cases if projections had been made which took into account the actual forecast supply but did not lead to excessive consumption through various forms of subsidy. These aspects are the deficiencies, which could be described as institutional, in the system of forecasting demand and supply and they must be corrected if a more effective system is to operate in the future. This task will of course have to be carried out within the context of the policies which each country determines in respect of these infrastructure services.

To remedy the lack of direct information on the volume of water used for each purpose, the requirements are calculated on the basis of coefficients obtained from technical literature on similar situations or on the basis of estimates of efficiency.

4. Areas where water supply and demand are of critical importance

Most of the economic activity of the region is located near the coast and on some of the high plateaux where the living conditions are relatively healthy and agreeable. The utilization of water is naturally concentrated in the densely populated areas with intense economic activity, and the conflicting requirements make it difficult to ensure an adequate supply.

It is frequently noted in Latin America that the more developed areas are those with annual rainfall of less than 2,000 mm and areas at high altitudes with scant rainfall. Thus, there are a number of areas where there are conflicting demands for the use of the resource despite the fact that in the same countries there is plentiful water

/in other

in other areas quite nearby. In Mexico 85 per cent of the water resources are in the areas situated at an altitude of less than 500 m, but 75 per cent of the population and 70 per cent of industry are to be found in the area situated above the 500-metre line.5/ In Venezuela 41 per cent of the water requirements of the entire country were concentrated in the central region in 1970, but the supply in that region represented only 16 per cent of the country's total.6/ Critical situations occur both when there is a shortage of water and when there is an excess in areas where there are major concentrations of population or economic activity.

The pressure on natural resources is generally greater when there is a simultaneous increase in population density and income.7/ Thus, the most pronounced adverse phenomena tend to be found in metropolitan areas with high incomes. Specifically, the resource is affected both by the concentrated demand which makes it necessary to extract large quantities from the natural watercourses and by its use for the washing away and subsequent elimination of wastes. In rural areas the pressure on the quality of natural resources, including water, is less intense, but even so there are major problems; in particular, there is the degradation of the soil through erosion with the subsequent washing away of solids by the rivers in mountain regions with high population density, subsistence agriculture and overgrazing and also, in the humid tropics, as a result of tree-felling. Environmental deterioration is also significant in agricultural areas where intensive use is made of fertilizers, herbicides and pesticides, and in some mining areas and non-urban industrial centres where concentrations of water pollution occur. Many of the substances

---

5/ Zoltan de Cserna, Pedro Mosino and Oscar Benassini, El escenario geográfico: Introducción ecológica, INAH, Mexico City, 1974.

6/ Venezuela, national report to the United Nations Conference on the Environment, Stockholm, June 1972.

7/ The structure of production and the technology employed are also important factors in this respect.

/discharged in

discharged in this way are neither bio-degradable nor able to settle out, and thus there is no possibility of natural purification of the watercourses which receive these effluents.

(a) Areas which are critical because of conflicts between users

In the big cities there is a concentrated demand for water which cannot be satisfied from local sources, so that it is necessary to seek supplies in increasingly distant places. This conflicts with the needs of former users of less economic significance than the cities, and in most cases displaces them. Furthermore, the refuse from the cities is discharged into the nearest watercourses, causing pollution, and in many cases the water deteriorates so much in quality that it cannot be used, this also affecting the former users.

These problems may be observed in several of the Latin American cities with over 500,000 inhabitants, where 28 per cent of the region's total population is concentrated (1975). They have been caused by the rapid and disorderly exodus from the countryside to the urban areas and particularly to the capitals, where the most varied and attractive opportunities are to be found. These cities are growing so rapidly that it is proving very difficult to expand the municipal services at the same rate and there are always strata of the population which are not supplied with sanitation services. If the current rate of growth continues, there will be enormous megalopolises by the year 2000: Mexico City, for example, will have 30 million inhabitants and São Paulo, 26 million.8/

(b) Areas which are critical because of shortage of water

(i) Areas which require irrigation. Despite the abundance of water in the region as a whole, it is necessary to make up for the lack of suitable rainfall by irrigation in many areas because of the

8/ United Nations, Department of Economic and Social Affairs, Population Division, working paper ESA/P/WP.58, New York, 1975.

irregular distribution of rainfall in both space and time. This shortage is usually found in areas which are most suitable for agriculture because of the quality of the soil, location and climate.

Plans to increase food production are being made throughout the region and it is estimated that it will be possible to double output in 15 years.9/ As agriculture intensifies it is becoming increasingly necessary to ensure a suitable water supply through irrigation. Areas which have a critical shortage of water in relation to the requirements of agricultural development include the central plateau of Mexico, where most of the population of that country is concentrated, north-west Venezuela, the Northeast of Brazil, the coastal region of Peru, most of the north-east and central-southern area of Argentina, particularly the Cuyo area, and the transverse and longitudinal valleys of Chile up to the 36º south parallel. These areas make a major contribution to the agricultural production of the respective countries, but the water resources are insufficient to develop the potential of the soil, climate and favourable location. Other areas where it is necessary to make up for seasonal deficiencies are not considered critical because wide stretches can be irrigated at a low cost with relatively simple regulatory and catchment facilities so as to obtain a second and even a third harvest, with consequent benefits for regional food production.10/ Table 7 shows the irrigation prospects in each country of the region.

Out of a harvested area of 91,080,000 hectares in 1974 11/ the irrigated area was about 12 per cent. According to the national reports, some countries have plans to irrigate about 85 per cent more land by the year 2000.

9/ Enrique Iglesias, La CEPAL y el desarrollo agrícola de América Latina, speech made at the ECLA/FAO Latin American Food Conference, Lima, April 1976.

10/ ECLA/FAO Food Conference, Short-term actions proposed, Item 10, Lima, April 1976.

11/ Estimate of the Joint ECLA/FAO Agricultural Division based on the FAO Production Yearbook, 1974.

/(ii) Zones

(ii) Zones with an acute shortage of water which are of national economic significance. The areas with an acute shortage of water are Lower California, the north and northeast of Mexico, the Guajira region of Colombia and Venezuela's broad coastal strip on the Pacific Ocean extending from latitude 4º South in northern Peru to approximately latitude 28º South in Chile, which includes the Atacama desert, and vast areas of southern South America including part of the Bolivian plateau, an extensive area of the Chaco (Bolivia, Paraguay, and Argentina), and the northeast, central-west and extreme south areas of Argentina (Patagonia).

These areas, in addition to those already considered which require irrigation, include others which are important for livestock raising (if there is a sufficient supply of water for the animals) or because of mineral wealth or major concentrations of population.

The most significant of these areas are the central coastal zone of Peru and the Bolivian plateau (on account of concentration of population), the desert in the north of Chile and the Bolivian plateau (for the importance of mining production to the national economy), and the Chaco area (Bolivia, Paraguay and Argentina), because of its stock-raising potential. The so-called "drought polygon" (Polígono das secas) in the Northeast of Brazil is a special case where, because of the wide variation in rainfall, there is a periodic threat of drought to over 25 million persons, although the average annual rainfall is relatively high and flooding sometimes occurs.

(c) Areas which are critical because of an excess of water

(i) Flood-prone areas. Large areas of the basins of the great Latin American rivers are constituted by very gently sloping plains which become flooded during the rainy season both because surface runoff is slow and because the rivers overflow.

/It is

It is estimated that there are some 600 million hectares of flood plains in the area known as the humid tropics,12/ of which some 50 million hectares have good soils and represent the most important area for agricultural expansion in tropical America. Most of these plains become arid during the dry season so that agricultural development is very limited and they are only used for free-range grazing.

The areas on the coast of the Gulf of Mexico, the Caribbean coast of Central America, the high Orinoco plains in Venezuela and Colombia, the plains around the lower reaches of the river Magdalena in Colombia, the Guayas plains of Ecuador, the Beni plains in Bolivia and the plateaux around the middle course of the Paraná in Argentina are of particular interest because they are currently used mainly for livestock.

(d) Other critical situations

Of the countries of the region, Guatemala, Honduras, Mexico, Nicaragua and all the Caribbean islands are directly affected by hurricanes and tropical storms.13/ Venezuela, Colombia and Brazil are not directly affected by these phenomena but are afflicted by floods every year in some of the major valleys. Because of the magnitude of the meteorological phenomena which cause these floods it is difficult to prevent the damage simply with corrective or protective works, and it is believed that the most effective course would be to set up an efficient early warning system and to regulate the utilization of the areas most exposed to these phenomena.

Paraguay, Uruguay and Argentina are also afflicted by floods due to rises in river levels, although to a lesser degree than the other countries mentioned.

12/ Phillip Z. Kirpich, Development of Lowland Tropical Flood Plains in Latin America, World Bank, April 1976 (mimeographed).

13/ Report of the UNDP/WMO/ECLA mission on flood and hurricane early-warning systems in Central America and the Caribbean, Mexico City, November 1975 (mimeographed).

/In the

In the Pacific basin, although floods are less extensive because of the smaller area of the river-basins, they occur extremely rapidly and, depending on the orographical structure, may cause landslides with catastrophic effects such as the one recorded in Huaylas, Peru as a result of the earthquake of 31 May 1970.

(e) Areas which are critical because of conflicts between users and environmental conditions

(i) Water pollution. It is the practice in all countries to discharge sewage and industrial effluents, as well as refuse and other residues, into the nearest watercourses, almost always without any kind of treatment. This is leading to critical situations in the environs of the large urban and industrial centres of the region. The rapid growth of cities and the extension of the sewerage service to wider areas is the main reason for this situation.14/ At the beginning of the current decade it was estimated that only 4 per cent of the urban population had sewerage services with some system of treatment or arrangements for at least partial control of pollution.

In view of the high costs involved it is not surprising that measures for the conventional treatment of effluents have been postponed, despite the sacrifice of aesthetic considerations and the problems of sanitation faced, and have been replaced mainly by curative health measures.

Since some cases are already reaching alarming proportions, however, preventive measures are now being studied, including the treatment of the various effluents.

Although there are supposed to be over 400 plants for treating urban effluents in the region, many of them are not in operation or are defective. An exception is the Dominican Republic, where 20 per cent of the population lives in towns which have plants for the treatment of effluents.

14/ See ECLA, El medio ambiente en América Latina, E/CEPAL/L.132/Rev.1, May 1976.

Industrial effluents also cause severe pollution. This applies particularly to the effluents from abattoirs and meat packing plants, tanneries, sugar refineries, paper and textile mills and, in particular, petrochemical and metals plants.

Very little information has been assembled on this subject, but most of the industrial centres of the region present varying examples of the pollution of the watercourses into which they discharge their effluents.

Pollution by chemical waste is often persistent (non-degradable) unless the waste is eliminated or neutralized by special forms of treatment. Water used for cooling, as in thermal and nuclear electricity generating plants, is almost all returned to the watercourses, where it produces thermal pollution of a temporary nature with generally localized effects.

Assuming that the use of water for industrial activities rises in proportion to the growth of this sector, pollution can be estimated to have increased at a rate of 6.7 per cent a year, which has been the growth rate of this sector during the last five years. It may be noted, however, that two polluting activities - paper and pulp, and iron and steel - have increased at double the average rate.

Almost all the countries of the region require the major mining corporations to take adequate steps to prevent their effluents from causing damage to watercourses, usually by emptying the effluents into storage areas where they do not cause pollution. However in some of these corporations, and in many smaller mines, these requirements are barely fulfilled, if at all, and this leads to dangerous pollution which is made worse by the fact that mineral effluents are non-degradable.

(ii) Water management in special ecosystems

The humid tropics. In the humid tropics, the expansion of the agricultural area reduces the vegetal cover and exposes the land to destruction by water erosion and the washing away of nutrients, with serious consequences. This also produces a change in the drainage

/system of

system of the rivers, because the duration of rain run-off is reduced and this leads to big spates, followed by periods when the flow almost dries up. Only rational land management can prevent the irreparable destruction of the soil in these regions.

The Andean zone. The steep gradients of the sides of the Andean valleys and the destruction of the vegetal cover lead to serious erosion which destroys the soil of these slopes, dumping the solid matter into the watercourses and producing banks which in turn cause floods in the lowland areas. Much of the land in the Andes chain and the mountain ranges of Mexico is affected by severe erosion. A similar phenomenon is to be found in southern Bolivia (Chuquisaca and Tarija) and northern Argentina (Jujuy and Salta). The washing away of solids by the river Bermejo leads to problems of sedimentation in the Paraná and the River Plate and according to some sources it even affects the port of Buenos Aires. In the outlying areas of some major cities the protective vegetal cover has been reduced and damage caused by erosion is to be seen (Mexico, Quito, Bogotá, La Paz).

Since the efforts made in the sphere of reafforestation have not been sufficiently intensive it is not yet possible to assess the results. It is interesting to note that in the basin of the river San José (El Salvador) a programme of reafforestation and rational soil use has been carried out very successfully with the assistance of FAO, and has prevented floods in the town of Metapan.

Areas with a tendency to become deserts. In some parts of the region the vegetal cover does not grow back once it has been destroyed, either because the soil loses its fertile elements from being exposed to the action of the eroding agents (water and wind) or because the current climatic conditions do not permit the growth of trees which would in turn favour the spread of undergrowth. When this tendency to turn into a desert occurs there is also a consequent change in the flow of the rivers which affects the utilization of their waters both because of irregularities in the supply and because of the entrainment of solids which affects hydraulic works and increases the costs of treating water to make it drinkable. The ecosystems in the

/the deserts

the deserts and mountain sides are very delicate and this explains the importance that is attached to the management of the mountainous areas of various Andean countries and the areas adjoining the desert regions of Argentina, Bolivia, Chile and Peru, among other countries.

/II. TECHNOLOGY:

II. TECHNOLOGY: ITS PROMISE, POTENTIAL AND LIMITATIONS

1. The main difficulties observed in the utilization of technology and the most suitable spheres for its application

(a) Limitations on the use of existing technology

In Latin America and the Caribbean as a whole there are a few select groups of professionals qualified in broad fields of development and in the management of water resources who keep abreast with the relevant technological advances in the world. However there are not enough of them to cover the needs and they are very unevenly distributed between countries, areas of specialization and levels of training.

In most countries the area best covered is probably civil engineering concerned with the design and preparation of projects for structural works, but in a number of countries there is a shortage of qualified personnel for the planning and evaluation of projects using the modern tools of socio-economic analysis. Paradoxically such planners do exist in some countries but they do not always find a positive response among the decision-makers, who generally continue to work on the basis of the intuitive methods of the past.

The importance of a multidisciplinary approach to the study of projects and the management of resources is frequently stressed but rarely put into practice. In particular, there is a lack of personnel to cover the environmental aspects of this work, although it is recognized that there are complex interconnexions in the development of water resources within the technological system and that there is a need to study these aspects.

There is also a pronounced shortage of personnel in the intermediate posts of technicians and skilled workmen. In the operation of irrigation works, in particular, the level of technology is far below that specified in the projects. In the sphere of sanitation projects, however, much work has been carried out on training, with the support of the Pan-American Health Organization, a subsidiary of WHO.

/The subsector

The subsector best provided with qualified personnel is undoubtedly that of hydroelectricity, where salaries are higher because of the nature of the technology employed, which is difficult to improvise, and the commercial nature of the subsector's development.

In order to adapt to future requirements, a constant effort must be made to promote the training of all kinds of technicians, mainly through the improvement of salaries, which in most cases are not very attractive. There will be no personnel of a calibre commensurate with the importance of the sector unless there is a change in this aspect. It is also necessary to adjust personnel training programmes in accordance with the real needs of the countries and to co-ordinate the activity of the various specialists. In Cuba, for example, it is estimated that by the 1980s it will be necessary to increase fourfold the number of persons currently working in the water sector; of these 17,000 would be university-trained staff and middle-level technicians.

In the more developed countries, techniques of systems analysis are being applied to the planning and evaluation of water projects. In this respect, praise is due for the efforts being made to overcome the usual limitations on such studies such as the lack of data, the tight schedules for the execution of individual projects because of the explosive rise in demand, and limited financial resources.

The spread of modern technology must be accompanied by social development in the rural areas, which are currently far from able to absorb advanced technologies in either irrigation or drinking water supply. The countries of the region are aware of this situation and are trying to find viable solutions with the support of bodies such as UNESCO, FAO, WHO/PAHO and other international and bilateral assistance agencies.

One successful example of the practical transfer of technology was the hydrogeological project carried out in the Northeast of Brazil (1965-1968) with the help of a French team. Personnel were trained at various levels in prospecting for water tables and in well drilling and operation, and the foreign techniques were adapted to the local conditions, and resources.

/Technicians in

Technicians in some countries draw attention to the lack of adequate financing and the budgetary constraints which hinder the acquisition of the instruments and equipment required for the use of particular techniques.

The disparity in the levels of technological development and of experience in the exploitation and use of water resources also indicates that there is not much exchange of information between the countries of the area.

(b) Technology in relation to water availability

In general the regulation of flow is a very effective method of increasing the supply of water during the periods when it is required, and it also provides reasonable security against the dangers of flooding. The construction of dams of various types (large, hill-side, torrent-correcting etc.) is also a technique which is widely used in the region and it can significantly improve supply from the point of view of quantity 15/ (see map 10).

In Latin America, despite the great potential of such measures, especially in the Andean valleys, very little attention has been paid to the rational management of the upper river-basins (including reafforestation and the control of grazing) which brings the concomitant advantages of regulating flow and limiting erosion and sedimentation in the lower stretches of the rivers. The technology of such management needs to be made more widely known at various technical levels. Although the technology of managing floodplains is familiar in the region, there is still great scope for future work in such fields as constructing control and protection devices (dikes), regulating the use of areas subject to flooding, and prevention and alarm systems.

15/ In some countries technicians recommend that the so-called "maximum reasonable dimension" of the sites suitable for the construction of dams should be used. This means replacing the traditional method of determining size on the basis of demand by one based on the maximum possible utilization of the river on the basis of topography.

/The subterranean

The subterranean water resources are exploited very little in the region and have much untapped potential. Up to now they have been used almost entirely for urban and industrial supply and, to a much lesser degree, for irrigation. The technique of recharging water tables by induced infiltration is little known or used despite the fact that this method of accumulating flow often works out much cheaper than surface dams. The combined management of surface and subterranean water resources still has great scope in Latin America. It is recognized that for this it will be necessary to build up and further disseminate the appropriate technologies.

The techniques of treating water to make it suitable for domestic and industrial use are widely known in the region. The Pan-American Centre for Sanitary Engineering and Environmental Sciences attached to the Pan-American Health Organization (PAHO/CEPIS) has carried out significant work in disseminating methods of making water fit for drinking at low costs of investment and operation, such as accelerated sedimentation, mixed stratum filters, coagulation aids, etc.

In some cases the subterranean water is brackish and may contain noxious mineral elements such as vanadium, arsenic, etc. There are some special techniques for the exploitation of these waters which are of interest for some countries, such as Argentina.

(c) Technology in relation to demand

Water is used very inefficiently in the region, especially in irrigation and for urban purposes, and the gross volume tapped at the source is much greater than the amount which should actually suffice on the basis of advanced technological models. Many national reports stress this aspect.

A very high proportion of the water tapped for agricultural use is lost in transit, particularly because of poor maintenance of the canals; in distribution it is lost through shortcomings in the works at the farm level and poor administration of the systems: and in the fields it is lost through faulty irrigation and control practices.

/Map 10


N
ESCALA
Megawatts
10.000
5.000
1.000
500
100
Mapa 9
AMERICA LATINA Y EL CARIBE
HIDRO-ELECTRICIDAD, CAPACIDAD INSTALADA,
POR DIVISIONES HIDROGRAFICAS PRINCIPALES 1974
LEYENDA
Límite de país
Capital de país
Ciudades de más de 1.000.000 de habitantes
División de cuencas
Fuente: CEPAL, Investigaciones en curso del proyecto Agua, Desarrollo y Medio Ambiente -ADEMA- (CEPAL / PNUMA)
Nota: El trazado de ríos en este mapa figuran determinadas fronteras no significa que sean reconocidas ni aceptadas por las Naciones Unidas


En la cuenca del Río Bravo (México) están incluidos los embalses Falcón y La Amistad (7.300 millones de m³) compartidos con los Estados Unidos
N
ESCALA
Millones de metros cúbicos
100.000
50.000
20.000
10.000
5.000
1.000
Mapa 10
AMERICA LATINA Y EL CARIBE
VOLUMEN DE EMBALSES EXISTENTES, POR DIVISIONES HIDROGRAFICAS PRINCIPALES, 1972
(Basado en datos de la 'International Commission on Large Dams' y de los países, 1973)
LEYENDA
Límite de país
Capital de país
Ciudades de más de 1.000000 de habitantes
División de cuencas
Fuente: CEPAL. Investigaciones en curso del proyecto Agua Desarrollo y Medio Ambiente -ADEMA- (CEPAL / PNUMA)
Nota: El hecho de que en este mapa figuren determinados fronteras no significa que sean sancionados ni aceptados por las Naciones Unidas

There are extreme examples, in certain irrigated areas, where the volume of water used could be reduced by half without modifying the systems employed, simply by eliminating wasteful practices. Even in Mexico, where particular attention has been paid to irrigation, the efficiency in a group of irrigated districts studied in connexion with the preparation of the National Water Plan (1975) was only 46 per cent. This inefficiency in utilization not only causes excessive demand which increases the overall costs of exploitation, but can also have adverse consequences on the soil by causing salinization and souring in some areas. There is also a great loss of water from the urban supply because of leaks in the mains, especially in the distribution networks. Some urban networks have recorded losses of 30 per cent and more.

Although local technicians are usually aware of the methods which would improve the efficiency of water use, little is done to introduce them because of the lack of trained personnel and also, above all, because the charges levied on users do not reflect the real cost of the water.

2. Limitations on the interchangeability of capital-intensive and labour-intensive techniques

There are high rates of unemployment and underemployment in Latin America, including rural areas, and the governments are anxious to solve this problem. Furthermore, the countries are generally trying to save foreign currency in order to improve their balance-of-payments position. Some water development projects seem advantageous from the point of view of attaining these objectives, since they use technologies which require the intensive use of labour and which involve savings of foreign currency on equipment and fuels.

Among such projects are the construction of medium-sized and small canals, protective dikes and smaller regulatory structures and in particular the clearing and levelling of land, and the construction of banks, levees, walls and other structures needed for irrigation, plus the work involved in the maintenance and general operation of the systems. In this respect it should be stressed that the use of a

/high proportion

high proportion of manual labour in such work is subject to the general economic conditions of each country, on which the construction bodies, owners of agricultural property and so forth base their decisions.

3. Elimination or reduction of the harmful effects of waste water disposal

The critical problems of the pollution of the watercourses of the region occur at well-defined points, being caused by the discharge of effluents from the major towns, some mining establishment, and industries located outside the towns.

The techniques of effluent treatment are known in the region but are not often applied. It is considered necessary to promote the use of new techniques of re-circulation and treatment and to adopt measures to induce private enterprises to assume responsibility for treating their effluents.

The use of settling ponds and oxidation pits offers good perspectives in Latin America for reducing the costs of treating liquid residues, especially in view of the low density of land use.

Among other examples, it is interesting to note the work which is being carried out in Brazil by the State Foundation for Environmental Engineering (FEEMA) and the State Company for Technology and Basic Sanitation (CETESB), and also the pilot plan initated in Peru for the treatment of the liquid waste of Lima and its subsequent re-utilization for irrigation in nearby fields (Lagunas de San Juan).

In the countries with high or medium levels of development it is considered vital that professionals should specialize in the treatment and re-utilization of a wide variety of industrial effluents and also in the obtaining of foreign techniques in the matter and their adaptation to local conditions.

4. Non-traditional techniques for increasing the water supply

In some countries of the region some interest has been shown in studying and applying special techniques both to increase the water supply in very arid areas and to alleviate the consequences of periods of drought.

/The techniques

The techniques tried, with varying degrees of success, include the de-salinization of water using energy from the sun or other sources (Argentina, Chile, Mexico and Peru), the artificial modification of climate by scattering condensation nuclei into the clouds (various countries), and the utilization of mists (Brazil, Chile and Peru). All these techniques produce only moderate quantities of water but are designed to solve the problems of supply in some islands and small inhabited areas, or to promote activities of high value.

Other types of special technology which have been tried are the melting of glaciers to increase the water supply in rivers during periods of drought (Chile) - a technique which can provide significant quantities of water for short periods - and the management of floodplains which pass through dry periods by controlling runoff by means of earth levees (Venezuela).

Other special techniques are designed to improve the efficiency of irrigation and thus diminish the consumption of water. Among these, almost all the countries have shown interest in irrigation by sprinkler or drip feed systems and these techniques already being used to a greater or lesser degree in many countries. The Cuban report indicates that in that country 170,000 hectares are currently being irrigated by sprinkler, and it is envisaged that 450,000 hectares will be covered by 1980. In Peru 64,300 hectares are being irrigated by this method.

Techniques to reduce losses through evaporation from the dams (Chile) and to make them waterproof (Argentina) have also been tried.

A special case which is closely connected with the subject is the transmission of electric energy over large distances at very high voltages. This makes possible the economic exploitation of hydroelectric resources at increasing distances from centres of consumption (Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela).

III. POLICY OPTIONS

1. Legislation and institutions

Throughout the region there is an evident desire to improve the institutional structures for the management of water resources, and a great deal of activity is observable in the field of water legislation. In the past decade new laws have been enacted or existing laws have been modified in at least 10 countries of the region,16/ and in nearly all the countries new institutional structures for water management have been attempted. Unfortunately, such recognition of the importance of the problems confronting water management has not always been complemented by an adequate allocation of funds or the necessary official support to enforce the competent authorities' decisions.

Despite the differences of opinion on the definition of water use rights between the Latin countries following the principles of Roman law and the English-speaking Caribbean countries following the Anglo-Saxon tradition of customary law, there is consensus in the region that this resource should be treated as a public good and its use should be regulated by the State.

The Legislation recently enacted in the region has been oriented towards providing an adequate legal framework for water management and establishing the relations between the water authorities and the rest of the institutions in the country.

Another highly interesting aspect is the relationship between water legislation, general legislation on natural resources and provisions concerning the environment.

Three groups of institutions may be distinguished in connexion with water management:

16/ Latin American seminar on legal and institutional aspects of water resources, Inter-American Centre for the Integrated Development of Water Resources and Land (Centro Interamericano de Desarrollo Integral de Aguas y Tierras - CIDIAT), Mérida, Venezuela, 1974.

/- those

- those having jurisdiction over the concession and management of water resources;
- those concerned with research on or the measurement of water resources; and
- the users of water resources.

The authority with respect to water is in the hands of those institutions which grant, administer and supervise its use. It may so happen, however, that an institution possessing such authority also performs the functions of measuring and studying the resource, or that functions in connexion with this authority are entrusted to an institution that uses water.

There are three types of water authorities in the region. In some countries, such as Mexico, Peru and Chile, a central institution directly subordinate to the Executive has been assigned maximum authority in this field.

In other countries, such authority is exercised by a council in which all the interested sectors are represented. The principal objective of these councils is co-ordination, and they have followed various paths according to the powers assigned to them by the authorities. In some cases the authority is in the hands of a commission, which has set up an executive secretariat and plays an important role in water resources planning, such as the Commission for the National Water Resources Utilization Plan (Comisión del Plan Nacional del Aprovechamiento de los Recursos Hidráulicos - COPLANARH) in Venezuela.

Lastly, in other countries (Trinidad and Tobago, Costa Rica) there is no clearly-defined authority and some of its functions have been assigned to the most important of the local institutions using water.

These authorities may operate at a national, regional or river basin level.

Argentina is the only country in which the provinces have legislative power over water resources. Water management through autonomous corporations for the administration of specific valleys or regions has been adopted in very few cases.

/Regional or

Regional or river basin management is quite different, since it is simply an internal administrative system within the context of a central institution, under a single supreme authority for the whole country. This kind of solution has been successful in some countries such as Mexico, which has organized its water management in this way within the framework of the Ministry of Water Resources.

Owing to the multi-sectoral nature of water use, to institutionalize its management presents serious problems and it is difficult to arrive at a wholly satisfactory organization or at formulas which may be applicable to all countries. Possibly the greatest concern in this respect is that the country's general economic planning should be made compatible with the specialized planning required for the utilization of water and with the proper autonomy for its study and management.

In practice, it is difficult to separate the management of water as a resource from sectoral plans and projects that include water as an input. Hence, the anxiety to try out various types of institutional structures which will reconcile the necessary unity of general water use policy with the inevitable dispersion of the technical offices working with these resources, whether as users or academic units. This problem is a source of some preoccupation in the region. It is generally considered that if institutions entrusted on an experimental basis with water management functions were provided with an adequate financing to carry out their work and given a sufficiently permanent status to train personnel, the utilization of water resources would rapidly improve.

Water legislation merely provides an adequate legal framework so that the type of water management (including water resources planning) can be the most suitable for the harmonious development of the country, but the law in itself does not produce such development. The same observation is applicable to the institutional

/organization of

organization of the water resources sector. If water management is to be really efficient, there must be an adequate institutional system with the indispensable financial support and backing for its decisions.

2. Planning

Water resources planning has emerged as a necessity in order to deal systematically with a problem which is closely linked with the rate of economic and social development and technological progress. The increasing demand for water, its relative scarcity in certain areas and the irrational use of existing supplies, partly owing to the inorganic dispersion of efforts, can set real limits on a balanced development and give rise to confrontations (competition or options) regarding the use of water, of both a sectoral and a geographical nature.

Accordingly, water resources planning should be included in the country's overall development strategies. At the same time, however, this resource requires separate treatment, in view of its special characteristics as regards both the technology of its use and its natural availability.

There is an evident trend in the countries of the region to assign an important role within the State administration to the planning of overall development strategies, the relevant functions being entrusted either to a specific ministry or to a unit within the Office of the President of the Republic.

Within the broad guidelines adopted for a country's development, national planning necessarily embraces water resources (as part of the sectoral and regional strategies); but precisely because of the general nature of those guidelines, it is impossible to prepare specific plans for integrated water management, so that a different type of planning is necessary for this resource. Lastly, the individual sectors using water will have to plan its use in terms of their own requirements.

It is not easy to achieve satisfactory co-ordination between the different users in order to arrive at a plan governing the use of water, and it is even more difficult to harmonize their proper subordination

/to national

to national development strategies with the flexibility and independence required for efficient water management. This dependency relationship is possibly one of the most difficult aspects to tackle within the institutional system.

In many countries of Latin America and the Caribbean there is dissatisfaction with respect to their institutional systems for water use planning, and a fervent hope that their modification will lead to a significant improvement in the use of this resource.

Most of the countries in the region have gone through the stages of water planning by sector of activity of users, by project and by work programme, without as yet formulating a national integrated plan - or master plan - for the use of water. It is only in recent years that interest has been shown in this stage, and, because of their wide coverage, mention is made, among others, of the plans under study in Cuba, Mexico, Nicaragua, Peru and Venezuela.

Perhaps what is most lacking in this area of planning, except in a very few cases, is the process of careful ex post evaluation of completed projects and implemented plans. Such an evaluation could be a very useful basis for the planning, programming, design, construction and operation of future projects and works, and for introducing the necessary institutional changes.

In the planning techiques adopted in the region there has been a considerable increase in the use of systems analysis and, in general, of all the techniques of operational research, the tendency being to study the programmes by means of advanced technologies. Of course, this assumption is mainly applicable to the relatively more developed countries. Some groups of professionals in the region are familiar with these techniques, but the greatest difficulty encountered in their use is the lack of reliable information in various subjects (including the availability of water), which comprises not only basic hydrometric data and information on other natural resources related to water, but also a systematic inventory of possible works, demand projections with a realistic assessment of the degree of technical efficiency which could be achieved in the use of water in each sector, the social cost of goods and services, etc.

/The factors

The factors conditioning the environment (including long-term changes in the eco-systems) constitute another complex field requiring information which is difficult to obtain and which, as far as water resources development is concerned can no longer be ignored.

The fact that the information described above is systematically compiled, analysed and made available to persons concerned with the formulation of plans and projects is generally considered to be one of the most useful ways of ensuring efficient and useful planning for the countries concerned. Moreover, in the adoption stage of a programme, it plays a decisive role in co-ordinating the various user sectors.

Fairly large-scale water use projects are generally of a multi-purpose nature, and their usefulness lies in combining economic, social and environmental benefits. If in the study of projects there is not the necessary unity of action on the part of the various user sectors (agriculture, energy, health, mines, etc.), the projects included in the programmes will offer benefits of a sectoral kind only instead of the maximum overall benefit. Institutional organization also plays a primary role in this stage of planning.

As a rule, efforts have been made to solve these problems by means of commissions in which all the sectors using water are represented, but it is difficult to harmonize the different economic weight - and, therefore, the different availability of trained personnel in some sectors such as energy - with the weight of other sectors with primarily social aims.

Lastly, in the project and evaluation stages, similar problems arise once again in connexion with institutional organization.

It is important to note that the sound water management also implies the efficient use of this resource and the elimination of waste. A preoccupation in the region today is to improve the relation between the water obtained and that actually used, since efficiency rates of 40 per cent and even lower are frequently found in some sectors, for example, irrigation agriculture. Nor do the other sectors escape

/this problem.

this problem. The countries are seeking to improve the relevant technologies in sectors such as agriculture and mining, and to train operational personnel with a view to substantially raising the level of efficiency in the use of water. The heavy investment involved in water projects and the conservation of such a vital resource as water requires that careful use be made of it, even in those cases where the natural supply is at present fairly plentyful.

In order to make the use of water more efficient, it is essential that planning should envisage the need to train personnel at all levels and, in particular, to promote sound practices governing water use, quality conservation at the source, and the upkeep of projects.

3. Sectoral strategies

(a) Water supply and sewerage

The natural population growth and accelerated process of urbanization will continue to intensify the needs of urban areas, where the new population that will have to be served in the present decade, in accordance with the goals established by the Ministries of Health in the region,17/ will number around 100 million inhabitants compared with 60 million in rural areas. Since, in addition, the unit cost of installations in the former case is considerably higher, investment needs would be divided in the proportion of 4 to 1.

No less important is the maintenance of the existing installations to ensure a constant and satisfactory water supply service in terms of quantity and quality. Specific reference was made to this point in proposing the aforementioned goals, reflecting a widespread situation of inadequate financing for these services.

As regards the strategies for dealing with these requirements, there is a high degree of consensus in the aims postulated by the Governments.

17/ Third Special Meeting of Ministers of Health of the Americas (Santiago, 2-9 October 1972).

Great importance is attached to the institutional arrangements necessary to ensure that the Governments' undertaking to achieve the proposed goals is fulfilled and that the resources, particularly those of a financial nature, required for this task are duly made available. New forms of support are needed to complement that which is provided by the State, as is inevitable in services with a considerable social impact, but which in practice is eventually restricted by conjunctural factors.

The widespread tendency in the region seems to be to use meters (among other countries, they are in use in Bolivia, Chile, Costa Rica, Cuba and Peru). This makes it possible to relate the charge for the service with the volume used, to use rates calculated to discourage waste (unit rates which rise as consumption increases) and to record any losses in the networks as the difference between the volume consumed by the users. In many countries, however, either because it is the traditional practice or because the investment involved in the use of meters is too high, the charge is still based on the cadastral value of the property concerned.

The participation of the users, not only in the rates system but also in the conception, construction and operation of water supply services, is suggested as an interesting possibility, particularly in the more neglected rural area.

The use of the community's own resources, both human and financial, facilitates the training of its workers, helps towards both the education of the consumer and the constant maintenance of the services, and constitutes an element of self-sufficiency which motivates the adoption of a system of co-ordinated community work and mutual support for other purposes. A source of water for household use in rural communities can frequently produce enough additional water to cover such needs as the irriguation of vegetables plots and to increase the local production of nutritive food for household use.

/The interest

The interest shown by international and bilateral agencies in the provision of adequate drinking water facilities for rural communities has led to many projects of benefit to them. During decades of experience, a primary objective of UNICEF and WHO/PAHO has been the provision of sources of drinking water that would reduce the high infant mortality and morbidity indexes and promote social development in rural areas.18/

Official action can do much to promote and ensure the continuity of such participation, by means of technical and financial assistance, training, etc. An interesting example of this is the work done in Brazil by the National Housing Bank through the Health Finance Fund (FISANE) on the execution of projects and works for the establishment, extension and improvement of water supply and sewerage systems in urban centres. The users of the Fund must propose a system of realistic rates that will ensure the amortization of the loan and the payment of the operating costs involved.

The major drinking water services have the tradition and the basic capacity but many of them need new impulses to overcome limitations in terms of capital and staff (particularly at the intermediate level), and rigidities and inefficiencies in the administrative systems. It is often only a matter of making better use of existing resources, either by strengthening the central authorities or by facilitating co-operation between the better endowed units (generally those serving the capital and major cities) with those which do not warrant the provision of adequate technical infrastructure.

Moreover, nearly all the countries indicate the desirability of promoting personnel training and research on technologies and norms that are consistent with the local situation.

As regards sewerage, the targets of the Ministries of Health for 1980 are the same as those for drinking water in rural areas, and

---

18/ At its annual meeting in 1976, the Executive Board of UNICEF reaffirmed the vital importance of expanding the basic services for children in developing countries, and the necessity that this group of interrelated and mutually supporting activities should include the supply of drinking water.

/slightly lower

slightly lower in urban areas (a coverage of 70 per cent instead of 80 per cent, or a reduction of the deficit by 30 per cent instead of 50 per cent). Considering the backwardness of these services (at the end of 1971 40 per cent of the urban inhabitants received this service and barely 2 per cent of the rural inhabitants), this represents a major task.

If it includes the many large cities where the plan is not only to extend networks but also to install plants for the treatment of waste water in order to control situations which are a serious threat to health and the quality of the water, it becomes a task of gigantic proportions which few countries appear to be tackling in an integrated manner.

The strategies in connexion with sewerage are similar to those described above for drinking water, since these services are closely interlinked and are generally in the hands of the same authorities. It might perhaps be as well to add that there are no criteria or methodologies for evaluating the economic and social feasibility of the treatment of waste water, because of such questions as the preservation of the environment which carry considerable weight and are only now being given priority in the majority of the countries.

(b) Water for agriculture

Agriculture is the activity which uses the largest volume of water, in some areas absorbing as much as 90 per cent of the total. Accordingly, the management of water for agricultural purposes is of capital importance within the general use of this resource.

Such management may have the following objectives:

- irrigation of crops and pastures, including washing of saline soil;
- drinking water for animals and agro-industry requirements;
- recovery of land liable to flooding, or undrained land.

There are different strategies for achieving each of these objectives.

(c) Irrigation

In the development plans of nearly all the countries of the region, irrigation agriculture has a highly important role to play in increasing food production, and a considerable expansion of the area under

/irrigation is

irrigation is envisaged. The aim in the region is to increase the irrigated area by 85 per cent between 1975 and the year 2000 (see table 6).

Such an increase in irrigated area, in general, calls for an improvement in irrigation technology in order to increase the efficiency and utilization of the infrastructure of master projects in almost the whole region.

It is considered that a prerequisite for improving irrigation technology is to ensure a supply of water suited to the particular type of cultivation. In fact, it is impossible to develop intensive agriculture if there is any chance that the necessary supply of water will not be available; efficiency in water use depends on whether water is available when it is needed. That is why flow regulation and the elevation of groundwater to supplement surface water in periods of scarcity are fundamental policies in agricultural water use.

Even in areas with an abundant supply, however, the use of water is seen to be excessive, and only partial use is made of the master projects constructed (dams, canals, deep wells, etc.). Nearly all the countries of the region indicate as their main policy the improvement of water administration and management on rural properties.

Each country, in accordance with its legislation and administrative organization, has dealt in its own way with the assignment, distribution and surveillance of water use in rural properties.

It is generally considered that a much higher level of efficiency could be expected in the use of water if there were an adequate institutional organization. In this respect, the major factors would be:

- an institutional organization that will ensure co-ordination of the various stages of the irrigation process, from the planning of water projects to agricultural production;
- production planning, taking into consideration the availabilities of water and hydrological forecasts;
- the maintenance and operation of irrigation projects by responsible organizations with the necessary technical capacity and guaranteed financing;

/- the

- the adoption of measures to prevent waste by supervising the use of water or, preferably, by charging for the service according to the volume used;
- extension of irrigation and soil conservation techniques;
- research on irrigation rates, by means of local experiments and the dissemination of their results.

(d) Drinking water for animals and agro-industry requirements

Although the volume of water consumed for these purposes is much less than that absorbed by irrigation, it is fairly important because there are extensive areas in the region devoted to stock-raising, the possibilities of which are limited by the almost complete lack of water in dry periods.

The principal means suggested for improving the supply of water for these purposes are: the utilization of groundwater and the construction of farm ponds for the collection of rain water; and the dissemination of adequate practices to prevent the pollution of water.

(e) Use of land liable to flooding

An extensive area of the region is made up of plains and other land liable to be flooded, which, as noted earlier, total some 50 million hectares of good quality soil. The importance of using this land can be appreciated if it is considered that it is five times the present irrigated area.

A major part of this land has no water in the dry season, which also handicaps its use at that time.

The strategies for the use of this land in the region include the following aspects:

- regulation of the use of plains, limiting the utilization of the most exposed areas. This course is chosen by several countries in which such land is used basically for stock-raising; instead of undertaking projects involving substantial investment, the land is used in its natural state with adequate stock management;
- adaptation of crop-farming techniques used in other similar regions, as in the case of rice on the lower Magdalena River (Colombia). Flood management to prolong the humidity in the soil (Apure, in Venezuela) is another interesting option;

/- execution

- execution of flow regulation, river bank protection and discharge projects. This entails heavy investment which is warranted only in high-productivity areas.

In considering the options for utilizing this land, several countries show justifiable concern at the ecological effects which the change in the use of the land might bring with it, and they consider it necessary to observe the behaviour of the soil in order to avoid damaging it with the change in type of production, or destroying it through erosion as a result of floods should the natural vegetation change.

4. Water for industry and mining

Water for industry raises two kinds of problem in the region: (i) small- and medium-sized industries located in urban centres increase the burden of the demand for public services and often benefit from the subsidies the latter receive in one form or another from public funds; and (ii) industry comes to those centres not in order to make use of their networks but in order to take advantage of their water resources, reducing the supplies available for other priority demands (drinking water) or for uses which, unlike industry, cannot be displaced (irrigation).

In either case, the contamination which industrial use adds to the bodies which receive used water tends to be considerable, and this involves another form of subsidy provided by the collectivity to the industries concerned.

Mining, whose demand is more inflexible in its location, has enjoyed certain rights in respect of water in the case of activities which are of special interest to the national or regional economy. Here again there are serious cases of contamination of waterways through mining discharges which generally are very slightly controlled.

Policies on the water needs of industry and mining present options which it is difficult to evaluate. On the one hand, there is a tendency to make industry absorb the cost of the water it uses from the public systems and it is even encouraged to economize through tariffs which penalize high consumption. There is also a tendency to restrict the installations which industry can set up on its own account when the resource is scarce or lacks the capacity to dilute suitably the

contaminating effluents, or to establish regulations which require additional investment (for recycling the treatment of effluents, etc.).

On the other hand, it is seen that such policies may discourage the implantation of activities which generate employment and necessary services, and they are only applied partially or with many exceptions.

While this may be a question of pressing considerations of general or regional economic policy, this course has led to critical situations of shortage and contamination of waterways, which suggests that great caution should be adopted in this regard.

5. Non-consumption uses of water

Production of hydroelectricity, the greatest non-consumption use of water, is expected to grow at an annual rate of over 10 per cent during the next 20 years. Known plans indicate that in the period 1975-1980 an additional hydraulic generating capacity of 55 million kW will be installed (58 per cent of the total generating capacity to be installed). It is highly possible that because of the situation brought about by the rise of world oil prices there will be still more opportunities to exploit hydroelectricity. Fifteen of the oil-importing countries of the region have a large hydroelectrical potential to exploit.

The countries are aware that to carry out such policies it is vital to co-ordinate sectoral water and energy policies in the light of development objectives, since hydroelectrical plants belong both to the water systems (hydrological basin or region) and to the interconnected electricity networks. Thus, for example, Guatemala combines a master plan for regional electrification with its master plan for national resources (water resources).

From the hydraulic point of view, the countries will have to harmonize hydroelectrical usage with activities such as irrigation or flood control, which are usually in conflict with it because they require the same water.

/When the

When the hydroelectrical plants need large reservoirs - most frequently the case in the region - the possibility must also be faced of disrupting the ecological balance.

In any event, as far as indirect effects are concerned, it is to be noted that Latin America has had a favourable experience with regard to the priority given to hydroelectrical projects in the organization of water resources and in the regional development associated with it; and that it has been the goal of the countries to make the fullest possible use of these dynamic elements on behalf of new zones. There are many hydroelectrical projects underway or under study, such as Itaipú (Brazil-Paraguay), Salto Grande (Argentina-Uruguay), Yaciretá (Argentina-Paraguay), Corpus (Argentina-Uruguay), San Juan (Costa Rica-Nicaragua), Cajón (Honduras) and Atitlán (Guatemala), which directly or indirectly involve large-scale works of national and international physical integration.

In view of the abrupt change in the economics of the generation of hydroelectric power, there is a more or less pressing need to review electrification plans so as to include plants which had earlier been rejected as being too costly. This may take time and money, since it includes the preparation of preliminary engineering projects whichwcall for a number of painstaking studies.

There is likewise, for the energy sector as a whole, a concern in many countries to revise, in view of the higher costs involved, their overall plans or rather the estimates that have replaced them in many of the countries. To do this requires a considerable amount of effort and specialized consultant services.

River navigation also presents new opportunities as a result of the rise in oil prices, since for long shipments of some size it is certainly a more economical form of transport than road or rail. For the countries (Paraguay, Panama) and regions (Paraná-River Plate,

/Upper Paraná,

Upper Paraná, middle and lower Magdalena, Orinoco from Ciudad Bolívar, the Amazon from Manaos, etc.), where navigation is vital, there is a tendency to ensure its viability by strengthening the infrastructure and carrying out administrative reforms. In other navigable sections of lesser national importance it may also be possible to maintain and even develop this means of transport.

The policies advocated in this field recognize above all, as in the case of energy, that it is necessary to harmonize activities related to water with transport sector activities.

There is less need here for water management intervention since it is a question of uses which do not greatly affect the resource. However, there are many cases (the lower Paraná is a good example) where the use of the tributary basins is contributing matter, through erosion, which is washed down and deposited in the lower river courses and mouths, thus hindering transport and giving rise to costly maintenance work.

Recreation and agriculture are two uses of water attracting more and more interest, although until recently they were left to their own devices without much official attention. Aquiculture is being systematically included in plans such as those of Cuba, Guatemala and Mexico.19/

Government policy attempts to protect the quality of the resource needed for these uses, often incompatible with the dilution of used waters for which rivers or lakes are also used. These are difficult choices, since on both sides there are social factors which it is difficult to assess.

In the case of aquiculture in particular, there is a great lack of information and research on the resource's possibilities and the necessary ecological precautions.

19/ In Mexico, fresh and salt water aquiculture should make it possible to meet the increases in the demand for fish and seafood until the year 2000 (presuming that sea fishing remains constant).

6. Financial questions

Investment in water development works in 1961-1970 was equivalent to some 7,700 million dollars. For the present decade, according to the general targets established by the International Development Strategy (transposed to the development requirements of different water activities) and to known national plans and sectoral programmes, it is estimated that the equivalent of some 22,000 million dollars should be invested. The distribution by major heading in each case should be:20/

	1961-1970	1971-1980
Water supply and sewerage	28	27
Irrigation and drainage	26	16
Generation of hydroelectricity	43	54
Knowledge, flood control, and others	5	3
Total	100%	100%
Total in dollars	7,700	22,000

As these estimates were made in 1973, the 1961-1980 programme did not take into account the sharp rise in the price of petroleum which was to follow, with the result that in fact projected investment in water management may be greater due to the stimulus given to hydroelectrical projects, which then represented more than half of investment in the sector.

In turn, increasingly widespread recognition of the need to increase food production as a fundamental element of economic policy in the years to come may give extra support to irrigation works, which

---

20/ These estimates are the result of a study carried out by ECLA in 1973 in the course of the first regional assessment of the International Development Strategy. The figures for investment carried out are reached by assigning average costs to the capacity installed in the period, and thus they do not correspond to real expenditure. For the future programme, estimated average costs were also assigned to the targets for work to be carried out and projects announced for the period.

/have been

have been questioned because of the low yield of existing works. A sustained rate should also be maintained for water supply and sewerage if it is intended to meet the targets for coverage by these services adopted by the countries, and taking into account the rapid process of urbanization at work in the region.21/

Thus investment in the sector is programmed to grow at over 11 per cent annually, a rather high figure. Because of the economic difficulties facing the majority of the countries, it is probable that this rate will not be fully reached, but in any case it is estimated that on average the share of investment related to water within gross domestic investment will rise and probably exceed 5 per cent in the decade 1971-1980 (against 4 per cent in 1961-1970).

Faced with the need to supply this capital, the choices open to the countries are naturally closely linked to the prevailing type of overall policy.

The social importance of the services water can provide is recognized, but the level of intervention assigned to the government tends to vary. In the past, consideration of the social value of the services has resulted in the predominance of high direct participation of the public sector, which has supplied the majority of the funds through the budgets of ministerial agencies or contributions (directly or by endorsing loans) to decentralized bodies. Bonds have been issued on the capital market only occasionally, and then in the energy sector.

Partly because of the shortage of capital of most governments of the region, and partly as an organizational measure in the allocation of resources aimed at reducing waste in the use of water, a policy is gaining ground in which government subsidies are reduced and there is greater self-financing through tariffs or charges for the services.

21/ The targets for 1980 were established by the Ministers of Health at the above-mentioned meeting in Santiago in 1972.

/This trend

This trend has been influenced by the recomendations of the loan-making bodies operating in the region, whose aid to the sector has been considerable. Loans granted in 1961-1970 by the World Bank (IBRD) and by the Inter-American Development Bank (IDB) amounted to a little over 2,200 million dollars, and the figure is close to 3,000 million for the present decade until now. Although the sums are not strictly comparable (because the time phases are different) they represent a considerable proportion of total investment.

The breakdown by heading and by loan-making body is as follows:22/

	1961-1970		1971-1975	
	IBRD	IDB	IBRD	IDB
Drinking water and drains	6	42	31	18
Irrigation and drainage	9	28	22	18
Generation of hydroelectricity	85	30	47	64
Total per cent	100	100	100	100
Total in millions dollars	1,070	1,170	1,170	1,730

It should be remembered that this is not all the external aid from public funds allocated to water projects, since considerable contributions have been received under bilateral agreements.

In any event, the countries of the region show an interest in external financing and many of them argue that it should become more flexible and rapid (including local costs, reducing bureaucratic formalities, etc.).

It is the hydroelectrical sub-sector which manages most easily to attract both national and international funds.

22/ Source: Bank statements and official communications.

/There are

There are many irrigation and land-improvement projects which have not in practice produced the expected economic results, and therefore financing in this area is difficult and calls for new approaches in the future. In general, there has been a tendency to underestimate the complementary activities for the basic project which are required in order to derive all the benefits from the projects, and thus the capital budgets have remained small. While the planning of such projects has progressed considerably, the basic approach continues to be oriented towards measuring the growth of the volume of goods and services rather than the role the projects play in rural development.

The criteria to assess projects and take decisions consider in general not only their expected economic profitability but also the important role they may play in achieving social objectives such as the improvement of the basic social infrastructure, the creation of employment, income redistribution, national integration, the reduction of regional imbalances, etc.

There are also criteria which stem from special circumstances, such as complementing investment which has already been carried out or completing unfinished projects (a relatively frequent case in the field of irrigation).

The project evaluation coefficients illustrate the situation which prevails in the region: high cost of money, shortage of cash and relative abundance of labour. Some countries use interest rates of nearly 13 per cent to calculate the present value of capital expenditure, while to determine the social price of labour market prices are multiplied by a coefficient of less than one (in one country it is 0.6). The exchange rate is usually charged nominally (in one case 33 per cent) in order to compare options with a larger or smaller proportion of imported goods.

7. Technological development

Most of the countries of the region stress the need to improve the technology used in water management and use, mainly by adapting the advanced methods developed in other places and by taking care that in so doing no distortions are made in local socio-economic structures.

Particular interest is shown in the techniques of computation and operational analysis, and in their application to water planning, including the carrying out of hydrological studies and work programming. There is also interest in the design of tariff structures which encourage a more careful use of the resource and the measurement of consumption.

Another necessary policy is seen to be to deepen basic knowledge of the resource, by supplementing the hydrometrical networks with additional parameters such as the quality of water, sedimentation, evaporation, groundwater levels, glacier movements, etc., which are currently not measured in a systematic manner. It is noted in this respect that it is desirable to adopt the new technology by which data series are generated on the basis of only brief or discontinuous statistics and to process and publish data with a view to obtaining complete and up-to-date information. The use of the data provided by artificial satellites and by radar, tracer isotopes and other remote sensors is also recognized as important for knowledge of the resource.

The highly sophisticated methods to increase the availability of water, such as desalinization or modification of the climate are considered to be of very local interest and it is suggested that there should be further studies on their application.

Most national reports indicate that personnel trained in various forms of exploitation of water resources are available but in insufficient number. There is clear interest in programmes of university grants which enable local personnel to become specialized in various technologies, and in training programmes, especially of an operational nature in water management and the installation and maintenance of networks of hydrometrical stations.

/The desirability

The desirability is mentioned of combining the training of local staff abroad with demonstration programmes and direct visits by foreign experts to the corresponding local offices in order to be able to give due consideration to local conditions.

Mention is also made, as an effective method of transferring knowledge, of periodical technical seminars and symposia of specialists from within and outside of the region, choosing topics of common interest to a number of countries, and of the strengthening and regional co-ordination of research and training institutes.

Some national reports mention technical and financial assistance received in this area, such as that provided by the United Nations Development Programme with a view to expanding and modernizing hydrometeorological and hydrological measurement systems and the desirability of increasing such co-operation.

8. Environmental and health considerations

In recent years in most countries of the region considerable emphasis has been placed on the wider environmental considerations related to water management. This interest in the environment has reinforced a longer standing concern for the health aspects of water management. Not surprisingly, the protection of the quality of drinking water is one of the major areas of concern where the greatest progress has been made. In all the countries, the Ministries of Health have environmental health programmes of long standing, many of which have been developed in collaboration with international and bilateral agencies. The relationship between water development activities and environmental health is widely recognized, particularly as water plays a significant role as a vector or vehicle of transmission in a number of widespread diseases, like malaria, yellow fever, schistosomiasis and all gastro-enteric diseases. At the same time the interdependence in an ecological sense between man and his environment, as well as the influence of ecological factors on health, has been accepted as a basic principle in the development of health policies.23/

23/ PAHO/PASB, Ten Year Health Plan for the Americas, Official Document Nº 118, Washington, January, 1973.

/Unfortunately, but

Unfortunately, but equally unsurprisingly, the efficiency observed in water supply and sanitation programmes has not yet, in general, been applied to the broader questions of environmental quality. These environmental aspects of the use and management of water and related resources do not have a long tradition of public concern, and action in most countries has been sporadic. Consequently, there is considerable room remaining for the definition of policies amongst the various options that are available.

(a) Institutional machinery

Largely as a result of the stimulus given by UNEP, a process of consolidation of existing dispersed machinery for the protection of the environment has begun in most countries but, in many, it has yet to reach a sufficiently advanced stage to be felt in operational policies and programmes. Both the form and level of consolidation vary considerably between countries. The developments being pursued in the region include the following:

(i) The drafting of new legislation for the protection of the environment in general, including water and other resources, which provides for the establishment of new environmental agencies.

(ii) The amendment of water codes or other legislation to strengthen control of the non-health aspects of water quality.

(iii) The regrouping of existing agencies in order to centralize environmental activities.

(iv) The adoption of specific policies, programmes and projects directed towards environmental protection within existing water institutions.

Examples include new environmental codes in Colombia and Mexico, amendments to water legislation in Jamaica and Brazil, the extension of the responsibilities of existing agencies to cover the environment as in the case of the Oficina Nacional de Evaluación de Recursos Naturales (ONERN), Peru and Secretaría de Recursos Hidráulicos (SRH) Mexico, and the upgrading of the priority given to water quality programmes in many countries.

/Despite the

Despite the advances that have been made, however, much remains to be done to achieve a fully integrated approach to the environmental consequences of water use, water development projects and water management decisions, generally. In many countries of the region the responsibility for the environment remains so dispersed, both legally and administratively, that no effective protection of the environment can be achieved and the existing legislation is little more than the expression of good intentions. For example, in the constitution of Panama it is established that conservation of the environment is a fundamental duty of the state, yet the legislation governing the use of water contains no workable regulations for achieving such an end. Similar situations have been reported by a large number of countries.

(b) Damage evaluation

Few countries in the region have progressed very far in the evaluation of damage to the environment. In those countries where due to the posession of a relatively highly developed secondary manufacturing sector contamination from industrial and urban sources is most severe, a beginning has been made. For example, the creation of evaluative and investigative institutions at the state level in Brazil and the co-operative system between Recursos Hidráulicos and Salubridad y Asistencia in Mexico. In many cases, evaluation activities are restricted to measurement of water quality from the viewpoint of human health. Even so, expansion has occurred in the capacity to evaluate damage to water quality; for example, since 1971 Mexico has put into operation 4 research institutes, 9 laboratories in different regions of the country and 9 mobile laboratories. Together these facilities cover 60 per cent of the area of the country.

In general, for the development of policies in this area it is necessary to bear in mind the close relationship between the criteria of regulations and the means to enforce them. For the state of the water environment to be evaluated monitoring systems, trained personnel, laboratories and research institutions must be treated as integral parts of one system. This is not an easy goal to achieve.

/(c) Special

(c) Special technology

Until recently, it has been usual to approach the consideration of the control of the contamination of water, or the preservation of water quality, in the following manner:

(i) study the physical aspects of the problem and collect data on the conventional parameters;

(ii) establish the level of contamination through the comparison of this information to the conventional limits;

(iii) identify the sources of pollution;

(iv) adopt a set of norms and standards from the general literature;

(v) design a programme of control.

In general, this approach has failed due to the difficulty of enforcing the regulations established under the control programme, the high costs, and impracticability of the programmes.

More recently, a new approach has begun to be applied which is less rigid and gives less weight to general parameters and rules. It consists of:

(i) the identification of the nature of the water quality problem and the access problem (considering also non-human members of the ecosystem);

(ii) determination of the level and type of damage being caused;

(iii) identification of the source of the damage;

(iv) determination of the range of alternative means and their costs;

(v) the design of a control programme which minimizes total costs, control costs and damage to society as a whole.

Within this framework, many new techniques for the control of potential environmental damage are beginning to be applied in Latin America. Mention may be made, for example, of the studies on the behaviour of contaminants in Guanabara Bay, Rio de Janeiro and the Cauca River, Colombia , carried out with the advisory services of CEPIS.

9. Strategies for extreme situations

The phenomena of the hydrological world are not subject to known rules, and knowledge of them is purely statistical. Extreme situations may arise anywhere and at any time, through an excess or a lack of precipitation, with widespread repercussions on the water users or on the valleys of the basin concerned. A distinction must be drawn between situations which are actually extreme (which recur over a very long period), and difficult situations which recur over shorter periods and for which measures may be taken to remedy to some extent their harmful effects, and strategies may be prepared.

The measures which must be taken to deal with such situations may be classified in three groups:

- socio-economic, to compensate and aid the victims;
- regulatory, to remedy the harmful effects of such phenomena;
- precautionary, to warn possible victims and reduce damage.

The first group of measures relates to the work carried out by the emergency and civil defense offices, which operate in all the countries and have little to do with water management itself.

Regulatory measures include both the building of dams, so as to store water for periods of shortage or to regulate floods, as well as the proper management of the basins so as to take advantage of the natural regulation provided by the vegetation and the cleaning and correction of river courses to facilitate the drainage of the water. Measures of this type have the greatest economic impact, since they provide adequate safety for the development of the threatened zone; however, they are only effective in situations which may be described as difficult, involving drought or floods.

For truly extreme situations, the regulatory work required would be so great that it would be difficult to justify carrying it out. It is not possible to execute works to store the water needed to provide against, for example, three-year droughts with precipitation of one-sixth the annual average, like the drought which hit part of Chile and Peru between 1968 and 1970, nor to provide a defense against hurricanes.

/Finally, the

Finally, the third group of measures, described as precautionary measures, include, inter alia, government regulations to restrict the use of highly exposed areas and measures prepared in advance for action in emergencies flood and hurricane warning systems, meteorological forecasts based on available data and the study of snow paths and glacier movements in order to make forecasts of flows at thaw periods.

Among hydrological phenomena it is perhaps hurricanes which cause the greatest damage, although it is limited to relatively small areas and over short periods. A special UNDP/WMO mission studied the problem and among its recommendations 24/ particular importance was given to the setting up of a flow and flood warning system the delimitation of floodable zones, the supplementing of observation networks with radar and radio sondes and the creation of an international co-ordination structure in tropical meteorology.

Flood warning systems have been tried out in the region for some rivers of great length in which the flood wave allows sufficient time to evacuate the zones which may be worst hit; these include the warning system on the Unare river in Venezuela, which has been of great benefit to the city of Barcelona situated at the mouth of the river.

10. Water resources of shared basins

The water resources of shared basins in Latin America are relatively little-known, despite the fact that almost all countries have signed international agreements covering the use of such resources. Fifteen of the region's continental international river basins are covered by some kind of agreement for study and development of the basin resources. In addition there are bilateral agreements dealing with frontier waters or reaches and tributaries of continental river basins. These agreements vary from formal treaties to exchange of notes, to joint declarations, to memoranda of agreement and finally to the rather informal "actas", which are the official notes of meetings of the interested parties.

24/ Alertas ante inundaciones y huracanes en el istmo centroamericano y el Caribe, UNDP/WMO/ECLA, 1975.

The majority of agreements are bilateral not only due to the fact that multilateral agreements, are more difficult to negotiate but also a consequence of the simple fact that in the region there are only 6 river basins shared by three or more countries. In addition, of those only the Amazon (shared by 7 countries) and the River Plate (shared by 5 countries) are of real economic importance. Most bilateral agreements are concerned with rivers and lakes as political boundaries between nations or with questions of free navigation. Agreements dealing with irrigation, hydropower and integrated or multipurpose river basin studies and development perhaps with exception only of those between Mexico and the United States, date from the second half of this century.

The levels of co-operation and the degree of institutionalization vary over a wide range. The agreements are in general limited to exchange of information and preliminary investigations and joint studies. Usually, a joint (or mixed) commission is created with equal representation of technical personnel from each nation. Examples of this type of agreement are many. Among the most important are those between Brazil and Uruguay on the Quarai and Mirim Lagoon, between Argentina and Uruguay on the Uruguay river, and between Peru and Ecuador for the use of the resources of the Puyango-Tumbes and Catamayo-Chira basins.

There are several examples of agreements which contemplate, in addition to joint studies, the formulation of joint projects. An example is the agreement between Bolivia and Peru on Lake Titicaca. Several recent agreements also include joint construction and operation of projects. This is the case, for instance, of the agreements between Argentina and Uruguay relative to Salto Grande on the Uruguay river and between Brazil and Paraguay on the Itaipú hydropower development on the Paraná river. A higher level of co-operation demands also a higher level of institutionalization. In the case of joint construction and operation of projects, such as those between Argentina and Paraguay (Yacyretá agreement of 1973) and Brazil and Paraguay (Itaipú agreement also of 1973) binational enterprises were created which have greater decision-making power than those of mixed commissions.

/An analysis

An analysis of existing agreements reveals that there is a general reluctance on the part of national governments to delegate power to an international body over which they do not have full control. In general mixed commissions and other institutional entities are given authority to decide only on strictly technical matters. Differences of opinion which cannot be solved by consensus within such entities are settled through traditional diplomatic procedures.

The only working multilateral agreements are those of the River Plate basin. In 9 years of operation the most important accomplishments of these agreements have been: (i) comprehensive knowledge of the water and other natural resources of the basins which represent a considerable improvement over pre-existing knowledge; (ii) various agreements on questions of principles, for example, it was resolved that bilateral agreements must precede development of all reaches of the basin's rivers forming international boundaries, while in the case of successive international rivers, each country may use the water within its territory as long as no significant injury is induced on the other reparians; (iii) as a basis for integration and co-ordination of policies and programmes within the basin, comparative legal and administrative studies have been undertaken; (iv) the concept of the basin as a geo-economic unit has been stressed and studies have been carried out on measures to improve navigation, interconnexion of road, rail and electricity networks, co-ordinated radio broadcasting regulations, and general improvement of communications. Many initiatives have not gone beyond the preliminary investigation stage. Practically, all implementation projects have been the result of bilateral agreements. The progress made can be attributed to a great extent to the atmosphere of co-operation between the countries which has been confirmed by the meetings of the Foreign Ministers of the River Plate basin.

In this basin other multilateral agreements have been reached which to a great extent are also the result of this spirit of co-operation, for example the agreement between Bolivia, Paraguay and Argentina on investigations and development of the Pilcomayo river.

/The idea

The idea of a continental convention establishing principles for the development and use of international rivers in Latin America can be traced to some of the early meetings of the Inter-American system. The Seventh Inter-American Conference in Montevideo in 1933, adopted a 10 point declaration 25/ on the industrial and agricultural use of water resources. The principles established by this declaration were not binding, nevertheless they have not only inspired other attempts at regional conventions but have been taken as a basis for many bilateral and multilateral agreements among Latin American countries.

Existing conventions or draft conventions will certainly continue to serve as valuable guidelines for the conduct of States. To a great extent, the same could be said of global conventions such as the principles adopted by the Stockholm Conference on the Human Environment and other instruments or recommendations of an international nature, regarding shared water resources.

25/ Resolution (LXXII) of the Seventh Inter-American Conference, held in Montevideo in 1933.